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AN ASSESSMENT OF BIOLOGICAL INTEGRITY AND IMPAIRMENT OF AQUATIC LIFE IN THE CLARK FORK RIVER AND ITS MAJOR TRIBUTARIES BASED ON THE STRUCTURE AND COMPOSITION OF ALGAE ASSOCIATIONS IN THE PERIPHYTON COMMUNITY
AUGUST 1991 AND 1992

Erich E. Weber

PhycoLogic
East Helena, Montana

Prepared for
State of Montana
Department of Health And Environmental Sciences

July 1993

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SUMMARY

Periphyton (benthic algae) samples were collected by the Montana Department of Health and Environmental Sciences (DHES) from natural substrates at locations on the Clark Fork of the Columbia River and selected major tributaries for the purpose of assessing water quality, biological integrity, and overall impairment of aquatic life; samples were collected at 25 locations in August 1991, and 24 locations in August 1992.

Samples were analyzed for relative abundance of non-diatom genera, dominant non-diatom phylum, and relative abundance of diatom species. Metrics calculated included: diatom species richness, Shannon diversity index and siltation index. The total percent relative abundance of diatom species in three pollution tolerance groups was used to calculate the pollution index. Shannon diversity index, pollution index, and siltation index values were used to assess biological integrity and overall impairment of aquatic life based on criteria developed by DHES.

The algae associations indicated generally poor water quality and biological integrity, and severe overall impairment of aquatic life in Silver Bow Cr. during both 1991 and 1992. Heavy metals and elevated nutrients were responsible for the serious pollution. The ACM Pond #2 discharge was also severely impaired.

Warm Springs Cr. had good to excellent biological integrity, with little or no impairment of aquatic life during both years.

Upper Clark Fork stations and the Mill-Willow Bypass generally had fair biological integrity and moderate impairment, with improvement noted in 1992 over 1991.

The Blackfoot R. was rated as having excellent biological integrity with no overall impairment of aquatic life during both 1991 and 1992, suggesting very high water quality in this major Clark Fork tributary.

All Clark Fork stations downstream of the Little Blackfoot R. had either good or excellent biological integrity ratings, with minor to no overall impairment of aquatic life indicated during both years. The Clark Fork reach through Missoula to Huson or Alberton is probably under somewhat greater environmental stress than immediately upstream or downstream.

The Bitterroot R. is apparently suffering from impacts related to extensive development in its drainage, indicated by elevated siltation index values, and only fair biological integrity with moderate impairment of aquatic life.

INTRODUCTION

In August 1991 and 1992, the Water Quality Bureau of the Montana Department of Health and Environmental Sciences (DHES) conducted benthic algae surveys at 25 sites on the Clark Fork of the Columbia River and selected tributaries as part of their ongoing Clark Fork Basin Monitoring Project. This report presents the results of taxonomic analysis of periphyton samples from these surveys, and interprets these data to assess water quality at the stream sites surveyed. Similar surveys have been conducted by DHES annually since 1986 (Bahls 1987 and 1989; Weber 1991).

Periphyton is the assemblage of small, often microscopic organisms (microinvertebrates, bacteria, fungi, and benthic algae) that live attached to or in close association with the surfaces of submerged substrates. Benthic algae typically dominate the periphyton community in most waters. They can be conveniently divided into two major groups: the diatoms and the non-diatoms, by the presence or absence of a rigid, siliceous cell wall. The taxonomy of both groups has been well established; however, due to their uniquely ornamented cell walls, diatoms are readily identifiable to species, while it is much more difficult, and therefore generally impractical, to identify non-diatom algae below the genus level.

Algae, and particularly the diatoms, are useful as biomonitors of water quality because they occur in very large numbers, are highly sensitive to physical and chemical factors, and have known environmental requirements and pollution tolerances unique to individual species (Bahls 1989). Plafkin et al. (1989) lists several other advantages of using algae for bioassessment:

1. Algae generally have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts. (Perennial and fossil algae, including expired but recognizable algae incorporated into the periphyton matrix, reflect longer term impacts).

2. As primary producers, algae are most directly affected by physical and chemical factors.

3. Sampling is easy, inexpensive, requires few people, and creates minimal impact to resident biota.

4. Relatively standard methods exist for evaluation of functional and non-taxonomic structural characteristics (e.g., biomass and chlorophyll) of algal communities.

5. Algal communities are sensitive to some pollutants which may not visibly affect other aquatic communities, or may only affect other communities at higher concentrations (e.g., herbicides and inorganic nutrients).

Ideally, the algae present in a periphyton sample would reflect the environmental conditions that existed at a particular stream location for up to several weeks prior to the time of sample collection. However, in addition to water quality, many factors can affect the types and amount of algae present at any given time. These include, but are not necessarily limited to, scouring streamflows, variable recolonization rates, seasonal succession, and sloughing of accumulated algae. By allowing adequate time for substrate recolonization following the spring spate, by sampling before major sloughing of algal biomass occurs in late summer and early fall, and by sampling at the same time each year, the effects of factors unrelated to water quality can be minimized. Monitoring conducted during the first half of August probably meets the aforementioned criteria. Additionally, it very likely encompasses the period of poorest seasonal water quality and maximum environmental stress on stream biota due to low streamflows, high water temperatures, and minimum instream dilution of wastewater discharges.

METHODS

Composite periphyton samples were collected by DHES Water Quality Bureau personnel in 1991 and 1992 from natural substrates at established monitoring stations on the Clark Fork and selected tributaries (Table 1 and Figure 1). Sampling was conducted from August 12 through 16 in 1991, and from August 10 through 13 in 1992. Samples were collected according to Procedure 6.2.2 (Periphyton) in the Water Quality Bureau's Field Procedure Manual (DHES 1989).

Each sample was processed and analyzed by PhycoLogic in the following manner: A subsample of the periphyton from each station was examined with an Olympus BHT compound microscope under 200X and 400X, and all soft-bodied (non-diatom) algae present were identified to genus. The relative abundance of cells of each genus was estimated using the following system:

- R (Rare): Fewer than one cell per microscope field at 200X, on the average;

- C (Common): At least one, but fewer than five cells per field of view;

- VC (Very Common): Between 5 and 25 cells per field of view;

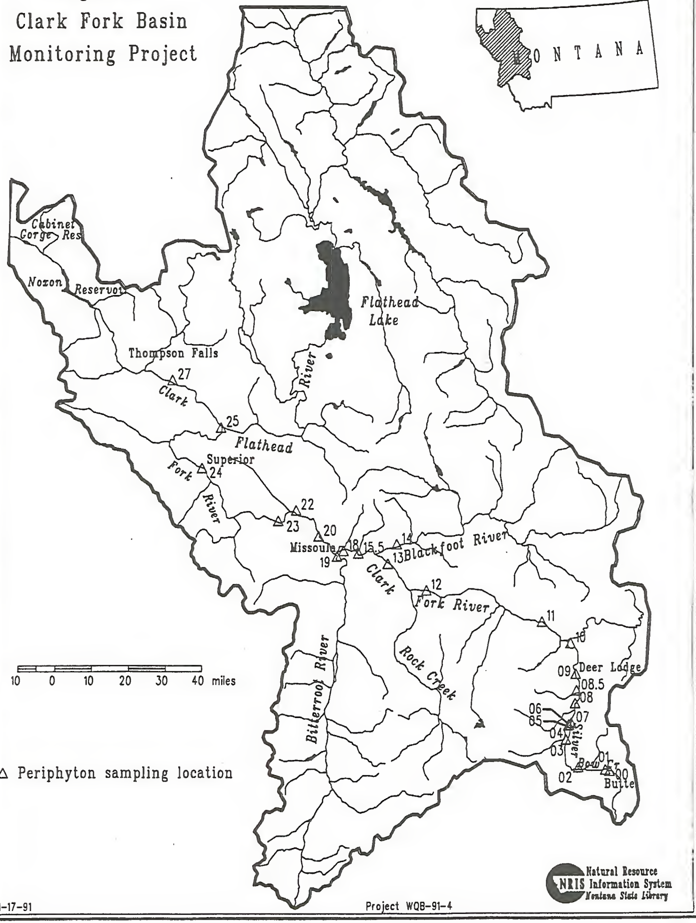
- A (Abundant): Greater than 25 cells per field of view, but numbers within limits reasonably counted;

- VA (Very Abundant): Number of cells per field too numerous to count.

Table 1. Periphyton sampling locations on the Clark Fork River and tributaries, 1991 and 1992.

Station	Site Description
00	Silver Bow Creek (SBC) above Butte Wastewater Treatment Plant
01	SBC below Colorado Tailings
02	SBC near Ramsay
03	SBC at Frontage Road above Warm Springs (ACM) Ponds
04	ACM Pond #2 Discharge (Silver Bow Creek)
05	Mill-Willow Bypass near mouth
06	Warm Springs Creek near mouth
07	Clark Fork River (CFR) below Warm Springs Creek
08	CFR near Dempsey
8.5	CFR at Sager Lane
09	CFR at Deer Lodge
10	CFR above Little Blackfoot River
11	CFR at Gold Creek
12	CFR at Bonita
13	CFR at Turah
14	Blackfoot River near mouth
15.5	CFR above Missoula
18	CFR at Shuffields
19	Bitterroot River near mouth
20	CFR at Harper Bridge
22	CFR at Huson
23	CFR at Alberton
24	CFR at Superior
25	CFR above Flathead River
27	CFR above Thompson Falls Reservoir

Figure 1.
Clark Fork Basin
Monitoring Project



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The abundance of diatom algae (all genera collectively) relative to the non-diatom genera was also estimated for comparative purposes.

Each dominant (common or greater in relative abundance) non-diatom genus (as well as the diatom component if it met this criterion) was also ranked according to its estimated contribution to the total algal biovolume present in the sample. The genus estimated to have the greatest biovolume was ranked number 1, the second most number 2, and so on. These rankings were used to calculate the dominant non-diatom phylum (see Non-Diatom Algae Metrics, below).

All organic matter was then chemically oxidized from each sample, leaving the siliceous cell walls (frustules) of diatoms and other inorganic matter. Permanent diatom strewn mounts were then prepared on glass microscope slides with Hyrax medium following Standard Methods (APHA et al. 1980). Each permanent mount was thoroughly scanned under 1000X oil immersion, and all diatoms encountered identified to species. A proportional count of approximately 400 (402-442, mean 417) diatom frustules was performed on each diatom mount, and the percent relative abundance of each species calculated. Diatoms identified during the floristic scan but not tallied during the count were noted as present.

Each diatom species was assigned to one of the three pollution tolerance (PT) groups initially determined by Lange-Bertalot (1979). Simply stated, Group 1 taxa are most tolerant of pollution, Group 2 taxa less tolerant, and Group 3 sensitive to pollution. Bahls (1993) published expanded autecological criteria for assigning diatom taxa to PT groups, along with an extensive listing of diatom taxa reported from Montana. Default PT group assignments (by genus) for taxa lacking sufficient autecological data were also determined. A number of unlisted taxa were assigned to PT groups by the author, based on updated autecological data in references by Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b). Default PT values were used as a last resort.

Non-Diatom Algae Metrics

Metrics applied to soft-bodied or non-diatom algae at each station include: number of genera, dominant phylum, and to a lesser extent indicator taxa.

The number of common non-diatom genera is generally inversely proportional to the degree of pollution in western Montana streams. In least impaired reference streams from mountain ecoregions in Montana, which included mountain valleys and foothills, Bahls (1992) reported from 1 to 10 common non-diatom genera, with a mean value of 5.

The dominant non-diatom phylum was determined by calculating the cumulative weighted rank of genera within each phylum based on estimated bivolume. Diatoms were not included in this metric. Briefly, in a sample with x number of common or greater non-diatom genera, the genus ranking highest in biovolume scored x points, second highest, x-1 points, and so on. The scores of all genera in each phylum were summed for each site to determine the dominant non-diatom phylum based on estimated relative biovolume.

Bahls et al. (1992) found that blue-green algae (phylum Cyanophyta) dominated the non-diatom flora of Northern Rockies reference streams, while green algae (phylum Chlorophyta) were co-dominant with blue-green algae in streams of the Montana Valley and Foothill Prairies ecoregion. The Clark Fork mainstem is considered to be primarily in the Montana Valley and Foothill Prairies ecoregion, as are the tributary stream reaches included in this monitoring.

Diatom Metrics

Metrics calculated for diatom associations at each station include species richness (number of species counted), Shannon diversity index, pollution index and siltation index. The total percent relative abundance (PRA) of species in each of the three pollution tolerance (PT) groups, and the PRA of three dominant diatom species in each PT group are also considered.

Species richness is probably the most basic indicator of community health and, as a rule, is directly correlated to water quality: as water quality declines, so does the number of species. In general, unpolluted waters in Montana have more than 25 diatom species counted (Bahls 1979). In reference streams from mountain ecoregions in Montana, between 23 and 51 (mean 33) diatom species were counted (Bahls 1992).

The Shannon diversity index (Weber 1973) considers the distribution of individuals among the species present along with species richness. High diversity values occur in diatom communities where no taxa are strongly dominant in numbers, which is generally the case in healthy, unimpaired streams. Diatom communities under environmental stress will have a relatively small number of taxa that account for most of individuals present, resulting in lower diversity index values. In general, unpolluted waters in Montana have Shannon diversity values greater than 3.00 (Bahls 1979). Diatom species diversity values of between 2.16 and 4.50 were found in 21 least-impaired reference streams from mountain ecoregions, with a mean value of 3.58 (Bahls 1993).

The pollution index was proposed by Bahls (1993) as a shorthand method of summarizing the information contained in the three pollution tolerance groups of Lange-Bertalot (1979). The index is derived from the decimal fraction of the total percent relative abundance (PRA) value of diatom taxa in each pollution tolerance group, multiplied by the respective group number. The sum of these three products is the pollution index. The index will range from 1.00 (all most tolerant taxa) to 3.00 (all most sensitive taxa). Pollution index values of between 2.45 and 2.94 (mean 2.72) were determined by Bahls (1993) for diatom communities in reference streams from mountain ecoregions.

The siltation index is defined as the total percent relative abundance of species of *Navicula*, *Nitzschia* and *Surirella* diatoms present (Bahls 1993). These genera were chosen because they are highly motile biraphidean diatoms well adapted to existence on unstable substrates. Values can range from 0 to 100; in mountain reference streams the index ranged from 0.0 to 50.3 (mean 14.5).

The last three metrics (diversity index, pollution index, and siltation index) are recommended by Bahls (1993) for use with a screening protocol (Protocol I) to assess biological integrity and impairment of aquatic life in Montana streams. Protocol I is intended for use when a local reference or control site is not available, and is based on data from least-impaired reference streams (Bahls et al. 1992, Bahls 1993). Data from streams in both the Northern Rockies ecoregion and the Montana Valley and Foothill Prairies ecoregion were combined for the mountain streams protocol, which will be used in this assessment. This protocol was developed with, and is recommended for use only with, metrics derived from data collected during the summer months.

Under Protocol I, each index is given an individual rating and assigned a score based on the value of that index in relation to a set of criteria (Table 5). The criteria correspond to varying levels of environmental stress, pollution and siltation. The lowest score determines the overall biological integrity and impairment rating for the aquatic community at that station.

RESULTS AND DISCUSSION

Non-Diatom Algae

The non-diatom algal genera identified at each of the Clark Fork and tributary stations, with estimated relative abundance and biovolume contribution rankings, are listed by phylum in Appendices A and B for the years 1991 and 1992, respectively. Diatoms (all genera collectively) are included for comparison. The number of dominant non-diatom genera (those common or greater in estimated relative abundance) and the dominant phylum (based on estimated biovolume; see methods) are presented in Table 2 for both years. The number of dominant non-diatom genera are also plotted in Figures 2 and 3 as green, blue-green and "other" (yellow-green, brown and red) algae.

Table 2. Number of dominant non-diatom algal genera, and dominant phylum, in periphyton samples from the Clark Fork and tributaries during August 1991 and 1992. ns = not sampled

Station	No. Dominant Taxa 1991	No. Dominant Taxa 1992	Dominant Phylum* 1991	Dominant Phylum* 1992
00	5	4	G	G
01	4	4	G	G
02	5	5	G	G
03	6	3	G	G
04	6	ns	G	ns
05	7	10	G	G
06	11	6	G	G
07	8	8	G	G
08	6	12	B	G
8.5	9	8	G	G
09	6	9	G	G
10	5	8	B	G
11	7	8	B	G
12	13	12	G	B
13	8	12	G	G
14	11	11	G	G
15.5	11	11	G	G
18	9	10	G	G
19	11	8	G	G
20	8	11	G	G
22	8	10	G	G
23	9	11	G	G
24	8	10	B,G	G
25	13	10	G	G
27	14	12	G	G

* B = blue-green algae (Cyanophyta)
G = green algae (Chlorophyta)

Figure 2. Number of non-diatom algal genera common or greater in estimated relative abundance in periphyton samples collected from the Clark Fork and tributaries during August 1991.

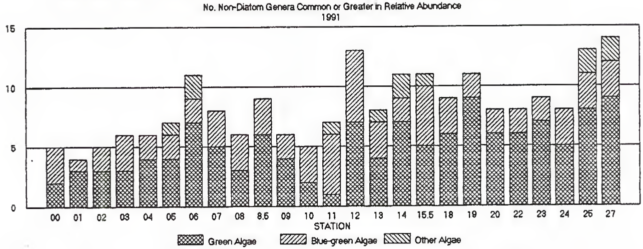
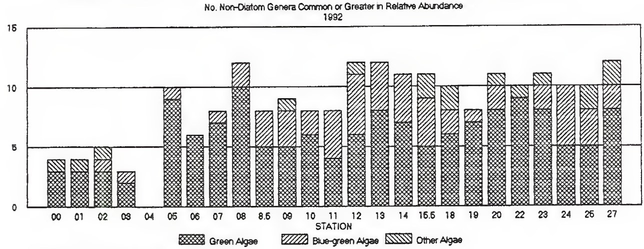
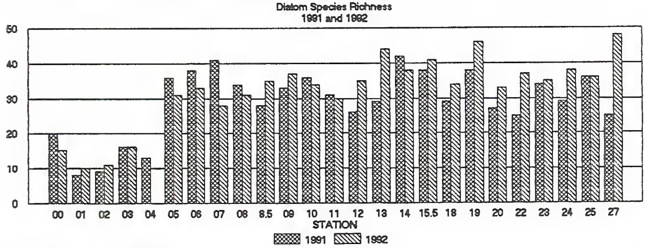


Figure 3. Number of non-diatom algal genera common or greater in estimated relative abundance in periphyton samples collected from the Clark Fork and tributaries during August 1992.



Station 04 not sampled in 1992.

Figure 4. Diatom species richness (species counted) in periphyton samples collected from the Clark Fork and tributaries in August 1991 and 1992.



Station 04 not sampled in 1992.

In 1991, the fewest non-diatom taxa were found at stations on Silver Bow Cr. and the upper Clark Fork (Figure 2). Only four taxa were present at Silver Bow Cr. below Colorado Tailings (station 01), which is also just downstream of the Butte municipal wastewater discharge and was likely under considerable stress. Slightly higher numbers were found at the other Silver Bow Cr. stations (including the ACM Pond #2 Discharge, station 04), with a weak positive trend with increasing distance downstream of station 01. However, all Silver Bow Cr. stations remained severely impacted by toxic metals and sediment from mine wastes along the floodplain.

The influence of the Mill-Willow Bypass (05) and Warm Springs Cr. (06), both higher quality tributaries, on the upper Clark Fork was evident in 1991 in the increased number of taxa at station 07 (below Warm Springs Cr). Numbers of non-diatom taxa generally declined at upper Clark Fork stations below 07, with the lowest number (five) found at station 10 above the Little Blackfoot R. The low numbers were likely due, at least in part, to toxic mine wastes and sediment impacts from poor land use practices, with dewatering for agricultural uses aggravating conditions in certain reaches. A notable exception was station 8.5 at Sager Lane, which with nine taxa probably reflects better water quality due to higher instream flows.

Below the confluence of the Little Blackfoot R., numbers of non-diatom taxa in the Clark Fork in 1991 generally increased downstream to station 15.5 (above Missoula), although a peak of thirteen taxa at station 12 (Bonita) did not carry to station 13 (Turah)(Figure 2). The Blackfoot R. (station 14) and the Bitterroot R. (station 19) had the same number of taxa present (eleven) as did the Clark Fork above Missoula. Numbers declined slightly to nine at station 18 (Shuffields) downstream of Missoula's municipal wastewater discharge, and slipped to eight at station 20 (Harpers Bridge) below the confluence with the Bitterroot River. Taxa numbers remained essentially the same at Clark Fork station 22 (Huson), station 23 (near Alberton) and station 24 (Superior), but jumped to thirteen at station 25 (above the Flathead R.) and fourteen at station 27 (above Thompson Falls Reservoir).

In 1991, green algae (phylum Chlorophyta) dominated the non-diatom algae at all Silver Bow Cr. and tributary stations, and at all but four of the sixteen Clark Fork stations. Blue-green algae (phylum Cyanophyta) were dominant at three stations, and co-dominant with green algae at one Clark Fork station (Table 2).

Pollution tolerant genera of non-diatom algae dominated at Silver Bow Cr. stations in 1991, but essentially disappeared below the Warm Springs (ACM) Ponds. These included the green alga *Gloeocystis* and the blue-green *Synechocystis*. The green algae *Scenedesmus* and *Stigeoclonium* were also present at Silver Bow Cr.

stations, probably in response to elevated nutrients and apparently in tolerance of heavy metals. Both genera, possibly represented by different species, also occurred at many of the downstream stations.

A relatively large and varied group of non-diatom algae was present in Warm Springs Cr., with *Oedogonium* and *Cladophora* the most prominent green algae present. The presence of the red alga *Audouinella* as a dominant suggests relatively good water quality.

The green alga *Cladophora* was dominant at nearly all Clark Fork stations in 1991. This conspicuous filamentous alga often develops expansive stands in riffles and runs, and serves as substrate and habitat for many microalgae and invertebrates. *Cladophora* is somewhat tolerant of low levels of heavy metals, and may not be as dependant on inorganic nitrogen levels as *Stigeoclonium* and other green algae. This may be due to a symbiotic relationship between *Cladophora* and the large numbers of nitrogen-fixing blue-green and diatom epiphytes typically colonizing its branched filaments (author, personal observation). *Cladophora* was absent from the Blackfoot R. in 1991, and was a lesser dominant in the Bitterroot R. and at the Clark Fork stations below the Bitterroot R. (station 20) and Flathead R. (station 27).

The three Clark Fork stations (stations 08, 10 and 11) where blue-green algae were dominant in 1991 (based on estimated biovolume) may have been naturally nitrogen-limited, which would favor taxa believed to have the ability to fix atmospheric nitrogen, including *Nostoc* and *Nodularia*. As noted earlier, *Cladophora* was also a dominant alga at these sites. At the majority of Clark Fork and tributary stations, the blue-greens *Oscillatoria* and/or *Phormidium* were important lesser dominants. These ubiquitous genera include many species that undoubtedly run the gamut from sensitive to tolerant of pollution.

Dominant non-diatom algae identified in 1991 from phyla other than the green and blue-green algae included a single genus from each of the yellow-green algae (Chrysophyta), brown algae (Phaeophyta) and red algae (Rhodophyta)(Appendix A). All are pollution sensitive forms and were found only in tributary streams, or at Clark Fork stations immediately downstream of tributaries. The brown alga *Heribaudiella* is an unusual and rare form with a very limited known distribution.

In 1992, Silver Bow Cr. stations by far had the fewest number of dominant non-diatom taxa present of all stations monitored (Table 2; Fig. 3). The number of taxa, if not the makeup, was the same (four) at stations 00 and 01, above and below the Butte municipal wastewater discharge. A slight increase at station 02 was followed by a decrease to only three taxa at station 03 (Frontage Road). At the time of the 1992 sampling, and unbeknownst to WQB field personnel, water from Mill Cr. and Willow Cr. that normally is diverted into the Mill-Willow Bypass was being shunted into the Silver Bow Cr. channel upstream of station 03 to allow for Superfund work on the Bypass channel. It is not known why the diversion had an apparent adverse effect on the biota at station 03. Field personnel did collect a periphyton sample at the established Mill-Willow Bypass location (station 05). It is now known that water flowing in the channel was apparently the result of seepage, and the relatively high number of taxa found at station 05, while possibly indicative of good water quality, cannot be considered representative of Mill or Willow Creeks.

The 1992 monitoring also saw the elimination of station 04, as Superfund activities had reconstructed the spillway structure on ACM Pond #2 to discharge directly into the Mill-Willow Bypass, abandoning the former discharge channel. The quality of water leaving Pond #2 in 1992, therefore, cannot be determined through periphyton bioassessment, except indirectly at site 07 below Warm Springs Cr.

The number of non-diatom taxa was nearly constant at upper Clark Fork stations from below Warm Springs Cr. (station 07) to Gold Cr. (station 11), with the exception of station 08 (Dempsey) where there were twelve rather than about eight dominant taxa. Instream flows at the time of the 1992 monitoring were very low, apparently a stable condition that favored periphyton growth. This also was the case downstream, from Bonita (station 12) to above Missoula (station 15) and beyond, with only minor variation in the number of non-diatom taxa at Clark Fork stations to above the Flathead R. (station 25). The Bitterroot R. had noticeably fewer dominant taxa than the Blackfoot R., which in turn was comparable, at least in numbers, to the lower Clark Fork sites. The number of dominant taxa below the Flathead R. at station 27 (above Thompson Falls Reservoir) was slightly higher than immediately upstream of the confluence.

In 1992, green algae (phylum Chlorophyta) again dominated the floras at all Silver Bow Cr. and tributary stations, and at all but one of the Clark Fork stations (Table 2). Blue-green algae (phylum Cyanophyta) were dominant only at station 12 (Bonita), based on estimated biovolume. However, blue-greens were well represented, if not dominant, at nearly all monitoring stations in 1992.

The filamentous green algae *Stigeoclonium* and *Ulothrix*, and the filamentous yellow-green alga *Tribonema* dominated the upper three Silver Bow Cr. stations (00, 10 and 02) in 1992. All are somewhat tolerant of pollution, although probably less so of heavy metals than of nutrients. Of these three genera, only *Stigeoclonium* was present at stations downstream of Silver Bow Creek. Colonial green and blue-green taxa that had been dominant in 1991 were entirely absent, or of only minor importance in Silver Bow Cr. in 1992.

As previously discussed, Silver Bow Cr. at station 03 was also carrying the diverted flows of Mill and Willow Creeks in 1992, and probably does not warrant comment beyond saying that the dominant green alga was the desmid *Cosmarium*, with little else present. Also, with the normal flow of the Mill-Willow Bypass diverted, and seepage accounting for all of the flow in the channel, there is probably little value in assessing the algae present at station 05 in 1992. The flora did have more in common with Warm Springs Cr. than with Silver Bow Cr., however.

Warm Springs Cr. was dominated by green algae in 1992 in contrast to 1991, when several genera from other algal phyla were also present. The green algae included *Mougeotia* and *Spirogyra* in addition to *Cladophora*; all are relatively clean-water forms.

The two uppermost Clark Fork stations, 07 (below Warm Springs Cr.) and 08 (near Dempsey), had the green alga *Oedogonium* as a primary dominant in 1992. This genus was also present, but was of minor importance, at tributary stations 05 and 06. Conditions in the upper Clark Fork, possibly related to the quality of the ACM Pond #2 discharge or to the changes in the Mill-Willow Bypass, apparently favored the growth of this relatively tolerant filamentous alga.

Virtually all Clark Fork stations in 1992 were again dominated by the filamentous green alga *Cladophora*. Very low instream flows and high water temperatures apparently favored unusually heavy growths at lower Clark Fork stations.

Blue-green algae were the dominant phylum at only one station in 1992 (station 12, at Bonita), but were still well represented at all other Clark Fork stations except 22 (at Huson), in the Blackfoot R., and to a lesser extent in the Bitterroot R. *Nostoc* was the dominant form at station 12, again possibly due to nitrogen-limited conditions. The blue-green genera *Oscillatoria, Phormidium* and/or *Rivularia* were the dominant forms at most stations, while the genus *Chamaesiphon,* a tiny epiphytic alga found almost exclusively on *Cladophora,* was a dominant at several stations between the Little Blackfoot R. and Missoula.

Two genera of red algae, *Audouinella* and *Asterocystis,* were relatively important at many Clark Fork stations, but primarily below Missoula. Both genera are considered to be intolerant of pollution. *Asterocystis* had been misidentified by the author as the green alga *Cylindrocapsa* in earlier Clark Fork monitoring (Weber 1991).

Diatom Algae

The estimated abundance values of diatoms (all genera considered collectively) relative to non-diatom algal genera at each of the monitoring stations in 1991 and 1992 are listed in Appendices A and B, respectively. Diatoms as a group are also ranked with non-diatom algal genera according to the estimated contribution that each made to each sample's total periphyton biovolume.

Diatoms were "dominant algae" (common or greater in estimated relative abundance) at all stations in both 1991 and 1992 (Appendices A and B). They ranked first or second in estimated biovolume relative to non-diatom algae at 20 of 25 stations monitored in 1991, and at 17 of 24 stations in 1992. The lowest biovolume ranking for diatoms in any sample during either year was fifth.

All diatom species identified during floristic scans and proportional counts performed on samples from 1991 and 1992 are listed in Appendices C and D, respectively. Percent relative abundance (PRA) values are presented by station for each diatom species counted. Lange-Bertalot pollution tolerance (PT) assignments are also listed for each species.

Diatom species richness at each monitoring station during 1991 and 1992 is plotted in Figure 4. The total percent relative abundance of diatom taxa in each of the three Lange-Bertalot pollution tolerance groups are plotted by station in Figure 5 for 1991, and in Figure 6 for 1992.

Metrics calculated for the diatom association from each station (Shannon diversity index, pollution index and siltation index) are listed in Table 3 for 1991 and Table 4 for 1992, and are plotted in Figures 7, 8 and 9 for both years. These metrics were used to rate the biological integrity and overall impairment of aquatic life at each station, based on criteria in Table 5. The ratings are listed in Tables 3 and 4, for 1991 and 1992, respectively.

The distribution of dominant diatom species from each of the three Lange-Bertalot pollution tolerance groups, by percent relative abundance, are plotted in Figures 10-12 for 1991, and in figures 13-15 for 1992.

In both 1991 and 1992, diatom species richness was very low in Silver Bow Cr. (stations 00-03), with far fewer than 25 species counted at all stations (Figure 4). Well over half of the diatom cells present at Silver Bow Cr. stations during both years were forms tolerant of pollution (Figures 5 and 6). The distributions of three most-tolerant diatom species (PT group 1) during 1991 (Figure 10) and 1992 (Figure 13) clearly show their dominance at

Silver Bow Cr. stations. Low Shannon diversity index and pollution index values, and high siltation index scores were characteristic of the Silver Bow Cr. stations during both years (Figures 7-9). Station 00 (above Butte Wastewater Treatment Plant) was rated as fair in biological integrity with moderate impairment of aquatic life in 1991 (Table 3), but slipped to poor integrity/severe impairment in 1992 (Table 4). The reverse was true for station 01 (below Colorado Tailings). Both Silver Bow Cr. stations 02 (near Ramsay) and 03 (at Frontage Road above ACM Ponds) were rated as having poor biological integrity and severe overall impairment of aquatic life during both 1991 and 1992 (Tables 3 and 4). The 1992 results from station 03 are somewhat questionable due to unknowns related to Superfund remedial activities. Elevated levels of heavy metals from historical mine waste deposits, nutrient enrichment from Butte municipal wastewater, and sedimentation from unstable streambanks are the most obvious causes of degradation of Silver Bow Cr.

Station 04 (ACM Pond #2 Discharge), which is basically Silver Bow Cr. after treatment, had a significantly higher pollution index score in 1991 than station 03 above the ACM Ponds. This was due to a lower total PRA of diatoms in PT group 1 (most tolerant)(Figure 5). While some improvement in water quality is indicated by the pollution index score, biological integrity/overall impairment of aquatic life remained poor/severe due to a high siltation index score (Table 3). Station 04 was eliminated in 1992 by Superfund remediation efforts.

Station 05 (Mill-Willow Bypass) had a relatively high diatom species richness value in 1991, compared to Silver Bow Cr. (Figure 4). Diversity index and pollution index values were also significantly higher than at Silver Bow Cr. stations (Figures 7 and 8). Biological integrity/overall impairment were rated as only fair/moderate due to a moderately high siltation index score. This was probably due to extensive unstable streambanks along the Bypass channel. The apparent marked improvement in pollution index and siltation index values at station 05 in 1992 was an anomaly. As was mentioned in the non-diatom algae section, Superfund remedial activities were diverting normal flows from the Bypass channel in 1992. It will be up to future monitoring to determine what effects channel reconstruction efforts have had on water quality.

Warm Springs Cr. (station 06) contributed very good water quality to the upper Clark Fork in both 1991 and 1992, as evidenced by high diatom species richness, diversity index and pollution index values, and low siltation index scores (Figures 4,6,7 and 8). Biological integrity/overall impairment of aquatic life were rated as good/minor in 1991 and excellent/none in 1992 (Tables 3 and 4). A relatively large increase in the total PRA of pollution sensitive (group 3) diatoms was noted in 1992 over 1991 (Figures 5 and 6).

Figure 5. Total percent relative abundance of diatom species in Lange-Bertalot pollution tolerance groups 1, 2 and 3 in diatom associations collected from the Clark Fork and tributaries during August 1991.

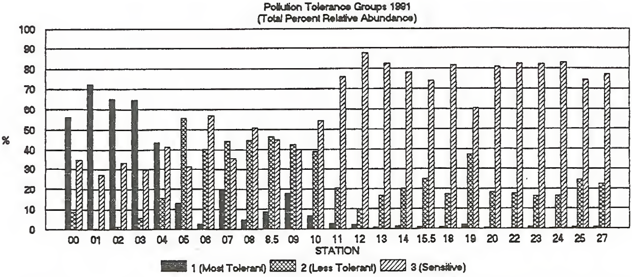
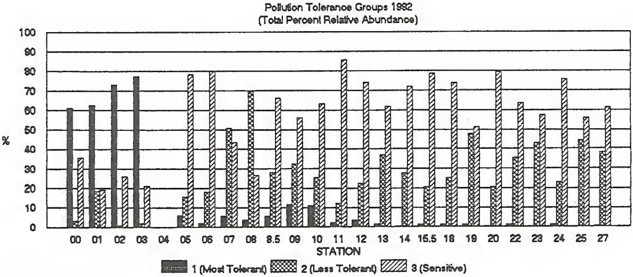


Figure 6. Total percent relative abundance of diatom species in Lange-Bertalot pollution tolerance groups 1, 2 and 3 in diatom associations collected from the Clark Fork and tributaries during August 1992.



Station 04 not sampled.

Table 3. Diatom association metrics, and biological integrity and overall impairment ratings for monitoring stations on the Clark Fork and tributaries during August 1991. Integrity and impairment ratings are based on scores in (), according to criteria developed by Bahls (1993). See Table 5.

1991 Station	Diversity Index	Pollution Index	Siltation Index	Biological Integrity	Overall Impairment
00	2.58 (4)	1.79 (2)	58.84 (2)	fair	moderate
01	1.77 (3)	1.55 (2)	70.84 (1)	poor	severe
02	1.96 (3)	1.68 (2)	66.19 (1)	poor	severe
03	2.43 (3)	1.65 (2)	65.80 (1)	poor	severe
04	2.43 (3)	1.98 (2)	78.05 (1)	poor	severe
05	3.93 (4)	2.18 (3)	40.96 (2)	fair	moderate
06	4.34 (4)	2.54 (4)	23.75 (3)	good	minor
07	4.47 (4)	2.15 (3)	46.19 (2)	fair	moderate
08	3.60 (4)	2.46 (3)	47.32 (2)	fair	moderate
8.5	3.45 (4)	2.36 (3)	55.17 (2)	fair	moderate
09	3.91 (4)	2.22 (3)	64.49 (1)	poor	severe
10	4.14 (4)	2.48 (3)	51.45 (2)	fair	moderate
11	3.45 (4)	2.73 (4)	29.71 (3)	good	minor
12	2.19 (3)	2.85 (4)	12.47 (4)	good	minor
13	3.36 (4)	2.82 (4)	16.87 (4)	excellent	none
14	3.96 (4)	2.77 (4)	14.39 (4)	excellent	none
15.5	4.10 (4)	2.73 (4)	25.36 (3)	good	minor
18	2.29 (3)	2.81 (4)	18.91 (4)	good	minor
19	4.29 (4)	2.58 (4)	42.54 (2)	fair	moderate
20	2.31 (3)	2.80 (4)	18.54 (4)	good	minor
22	2.32 (3)	2.82 (4)	16.63 (4)	good	minor
23	2.82 (4)	2.81 (4)	15.04 (4)	excellent	none
24	3.50 (4)	2.83 (4)	20.71 (3)	good	minor
25	3.95 (4)	2.73 (4)	15.33 (4)	excellent	none
27	2.85 (4)	2.76 (4)	3.37 (4)	excellent	none

Table 4. Diatom association metrics, and biological integrity and overall impairment ratings for monitoring stations on the Clark Fork and tributaries during August 1992. Integrity and impairment ratings are based on scores in (), according to criteria developed by Bahls (1993). See Table 5.

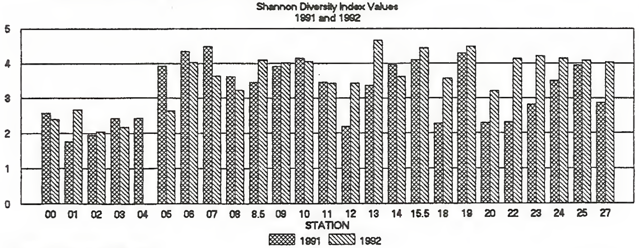
1992 Station	Diversity Index	Pollution Index	Siltation Index	Biological Integrity	Overall Impairment
00	2.40 (3)	1.74 (2)	62.30 (1)	poor	severe
01	2.67 (4)	1.57 (2)	58.45 (2)	fair	moderate
02	2.06 (3)	1.53 (2)	73.33 (1)	poor	severe
03	2.17 (3)	1.44 (1)	77.57 (1)	poor	severe
04	-	-	-	- not sampled -	
05	2.64 (4)	2.72 (4)	11.48 (4)	excellent	none
06	4.04 (4)	2.78 (4)	17.79 (4)	excellent	none
07	3.62 (4)	2.38 (3)	35.29 (3)	good	minor
08	3.22 (4)	2.23 (3)	56.10 (2)	fair	moderate
8.5	4.09 (4)	2.60 (4)	21.85 (3)	good	minor
09	4.02 (4)	2.44 (3)	41.40 (2)	fair	moderate
10	4.05 (4)	2.52 (4)	38.57 (3)	good	minor
11	3.41 (4)	2.83 (4)	17.63 (4)	excellent	none
12	3.42 (4)	2.71 (4)	23.44 (3)	good	minor
13	4.64 (4)	2.61 (4)	31.30 (3)	good	minor
14	3.61 (4)	2.72 (4)	10.19 (4)	excellent	none
15.5	4.42 (4)	2.77 (4)	22.03 (3)	good	minor
18	3.55 (4)	2.73 (4)	32.78 (3)	good	minor
19	4.48 (4)	2.50 (3)	42.17 (2)	fair	moderate
20	3.20 (4)	2.79 (4)	25.30 (3)	good	minor
22	4.12 (4)	2.62 (4)	33.91 (3)	good	minor
23	4.20 (4)	2.57 (4)	30.88 (3)	good	minor
24	4.14 (4)	2.75 (4)	17.97 (4)	excellent	none
25	4.09 (4)	2.56 (4)	16.82 (4)	excellent	none
27	4.04 (4)	2.61 (4)	7.71 (4)	excellent	none

Table 5. Criteria for establishing impairment ratings and scores for diatom association indexes from mountain streams under bioassessment Protocol I (Bahls 1993).

Score	Rating	Diversity Index	Pollution Index	Siltation Index
1	high stress	<1.00		
	severe pollution		<1.50	
	heavy siltation			>60
2	moderate stress	1.00-1.75		
	moderate pollution		1.50-2.00	
	moderate siltation			40-60
3	minor stress	1.76-2.50		
	minor pollution		2.01-2.50	
	minor siltation			20-39
4	no stress	>2.50		
	no pollution		>2.50	
	no siltation			<20

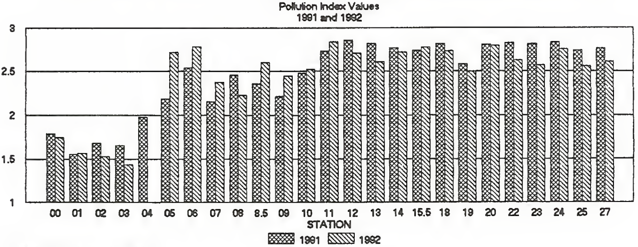
Lowest Score	Biological Integrity	Overall Impairment
1	poor	severe
2	fair	moderate
3	good	minor
4	excellent	none

Figure 7. Shannon Diversity Index values for diatom associations collected from the Clark Fork and tributaries during August 1991 and 1992 (see Methods section).



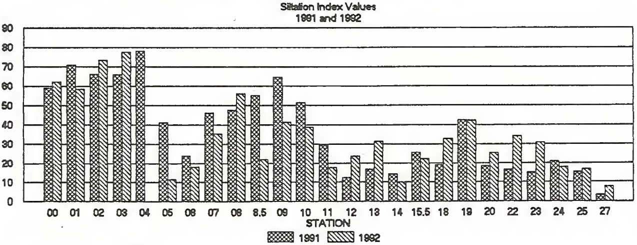
Station 04 not sampled in 1992.

Figure 8. Pollution Index values, based on Lange-Bertalot pollution tolerance ratings, for diatom associations collected from the Clark Fork and tributaries during August 1991 and 1992 (see Methods section).



Station 04 not sampled in 1992

Figure 9. Siltation Index values for diatom associations collected from the Clark Fork and tributaries during August 1991 and 1992 (see Methods section).



Station 04 not sampled in 1992.

Figure 10. Percent relative abundance values for three dominant pollution tolerant diatoms (Lange-Bertalot group 1) in diatom associations collected from the Clark Fork and tributaries during August 1991.

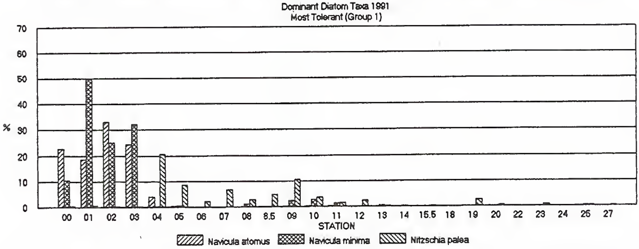


Figure 11. Percent relative abundance values for three dominant pollution tolerant diatoms (Lange-Bertalot group 2) in diatom associations collected from the Clark Fork and tributaries during August 1991.

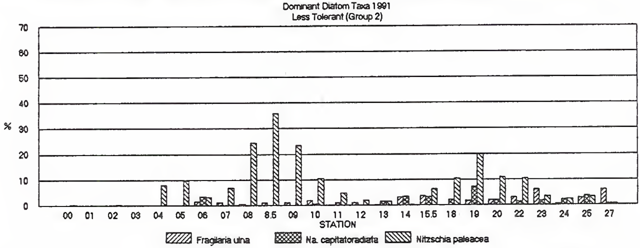


Figure 12. Percent relative abundance values for three dominant pollution sensitive diatoms (Lange-Bertalot group 3) in diatom associations collected from the Clark Fork and tributaries during August 1991.

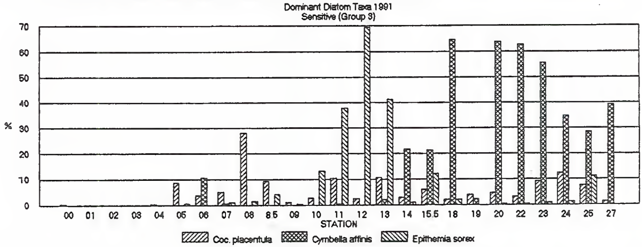
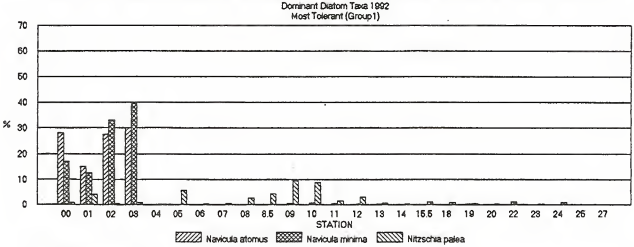
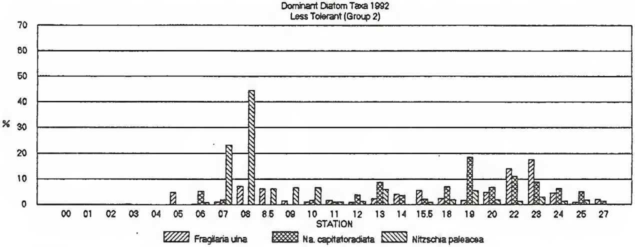


Figure 13. Percent relative abundance values for three dominant pollution tolerant diatoms (Lange-Bertalot group 1) in diatom associations collected from the Clark Fork and tributaries during August 1992.



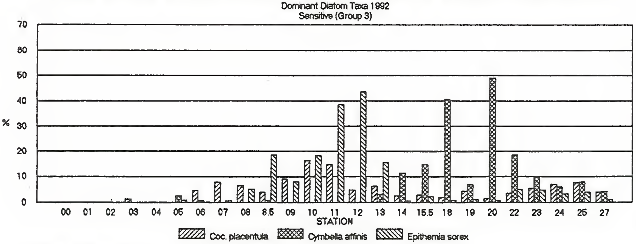
Station 04 not sampled.

Figure 14. Percent relative abundance values for three dominant pollution tolerant diatoms (Lange-Bertalot group 2) in diatom associations collected from the Clark Fork and tributaries during August 1992.



Station 04 not sampled.

Figure 15. Percent relative abundance values for three dominant pollution sensitive diatoms (Lange-Bertalot group 1) in diatom associations collected from the Clark Fork and tributaries during August 1992.



Station 04 not sampled.

At Clark Fork station 07, (below Warm Springs Cr.), as would be expected, conditions reflected a mix of the three upstream tributaries (stations 04,05 and 06) from the standpoint of water quality and its effect on the biota. In 1991, species richness and Shannon diversity values were the highest of any of the Clark Fork stations (Figures 4 and 7), although the pollution index (Figure 8) was depressed by the relatively high total PRA of diatoms in PT groups 1 and 2 (Figure 5). However, it was the elevated siltation index value (Figure 9) that resulted in biological integrity/aquatic life impairment ratings of only fair/moderate (Table 3). In 1992, somewhat lower species richness and Shannon diversity index values probably reflected similar declines in the tributary stations. The slightly higher pollution index value was the result of lower total PRA of diatoms in PT group 1. The lower siltation index score was responsible for the improvement of integrity/impairment ratings to good/minor at station 07 in 1992.

In 1991, the four Clark Fork stations from near Dempsey (station 08) downstream to above the Little Blackfoot R. (station 10) had much in common with station 07 (below Warm Springs Cr.). Species richness and Shannon diversity index values declined slightly through station 8.5 (Sager Lane), then rebounded to near upstream levels by station 10 (Figures 4 and 7). Pollution index values exhibited a slight increase at station 08, then followed the same pattern as the other metrics through station 10 (Figure 8). However, siltation index values increased steadily through the reach, peaking at a near-Silver Bow Cr. level at station 09 (Deer Lodge). Ratings for biological integrity/overall impairment at station 09 were poor/severe, the worst at any Clark Fork or tributary station below Silver Bow Cr. during 1991 or 1992, while the others remained at fair/moderate (Tables 3 and 4). In 1992, biological integrity/overall impairment of aquatic life ratings alternated between fair/moderate (stations 08 and 09) and good/minor (stations 8.5 and 10), with siltation index again the deciding factor. Pollution index values at these stations fluctuated somewhat as in 1991, but on the average were slightly higher than in 1991. Diatoms from pollution tolerance group 1 (most tolerant) and group 2 (less tolerant) reached lesser maxima in the reach between Warm Springs Cr. and the Little Blackfoot R. during 1991 (Figures 5,10 and 11) and 1992 (Figures 6,13 and 14).

At Clark Fork stations between the Little Blackfoot and Blackfoot Rivers in 1991, diatom species richness and Shannon diversity index values declined at station 11 (Gold Cr.), continued to slip at station 12 (Bonita), then rebounded somewhat at station 13 (Turah). This was caused by the predominance of a pollution-sensitive diatom species, *Epithemia sorex* (Figure 12), that may have had a competitive advantage due to symbiotic relationship with an endophytic, nitrogen-fixing blue-green alga (Bahls and Weber 1988). Pollution index values continued an upward trend that began at station 10, reaching a maximum at station 12, while siltation index values in 1991 continued to decline to very low values at stations 12 and 13. A net improvement in water quality through this reach in 1991 was reflected in biological integrity/aquatic life impairment ratings of good/minor at stations 11 and 12, and excellent/none at station 13 (Table 3). In 1992, the trend was essentially the opposite, as pollution index values declined slightly over the three stations while siltation index values steadily increased. Biological integrity/overall impairment was rated excellent/none at Clark Fork station 11 (Gold Cr.), but dropped to good/minor at both Bonita and Turah due to increases in the siltation index. Species richness and Shannon diversity did increase through the reach, and were considerably higher at stations 12 and 13 in 1992 than in 1991. *Epithemia sorex* was less dominant at these stations in 1992 (Figure 15).

The Blackfoot R. (station 14) had the highest diatom species richness of any station monitored in 1991 (Figure 4). Diatom numbers were strongly dominated by forms sensitive to pollution (Figure 5). The Shannon diversity index (Figure 7), pollution index (Figure 8) and siltation index (Figure 9) values all indicated very good water quality in the lower Blackfoot R., which earned biological integrity/overall impairment ratings of excellent/none (Table 3). In 1992, diatom metrics were very nearly the same as 1991, and the Blackfoot R. was again rated as having excellent biological integrity with no overall impairment of aquatic life (Table 3).

Clark Fork stations 15.5 (above Missoula) and 18 (at Shuffields) are located below the confluence of the Blackfoot R., but above the point where the Bitterroot R. joins the Clark Fork. They essentially straddle the Missoula urban area, with station 18 located downstream of the discharge from Missoula's wastewater treatment facility. In 1991, Shannon diversity at station 15.5 was quite high, comparable to the Blackfoot R. station 14, but dropped off markedly at station 18 (Figure 7). This was due to the very high PRA of one diatom species, *Cymbella affinis*, a pollution sensitive form that probably was responding to an increase in inorganic nutrients at station 18 (Figure 12). The pollution index was slightly higher, and the siltation index slightly lower, at station 18 than at station 15.5 in 1991 (Figures 8 and 9). These metrics do not indicate appreciable degradation of water quality in the Clark Fork due to Missoula's wastewater. Both stations 15.5 and 18 were rated as having good biological integrity with minor overall impairment of aquatic life (Table 3). In 1992, although biological integrity/overall impairment remained good/minor both above Missoula and at Shuffields (Table 4), slightly lower pollution index and higher siltation index values at station 18 (Figures 8 and 9) may indicate a slight increase in stress below the WWTP. This was possibly related to low instream flow conditions noted in 1992 (WQB field notes, unpublished). Lower Shannon diversity at station 18 was again due to the relatively high abundance of *Cymbella affinis* (Figure 15).

The Bitterroot R. (station 19) had relatively high diatom species richness and Shannon diversity values in both 1991 and 1992 (Figures 4 and 7). However, pollution index values were somewhat lower at station 19 than at the Blackfoot R. and adjacent Clark Fork stations during both years (Figure 8) due to higher numbers of diatoms belonging to PT group 2 (Figures 5 and 6), which are tolerant of pollution in lesser amounts. High siltation index scores at station 19 during both years (Figure 9) resulted in biological integrity/ overall impairment ratings of fair/moderate (Tables 3 and 4).

Clark Fork stations 20 (Harper Bridge) and 22 (Huson), above and below Stone Container Corporation's wastewater discharge, had much in common with station 18 (Shuffields) during 1991. Shannon diversity values (Figure 7) continued to be depressed by large numbers of *Cymbella affinis* (Figure 12), while very high pollution index values and low siltation index scores suggested good water quality (Figures 8 and 9). The relatively low diversity index values resulted in biological integrity/ overall impairment ratings of good/minor for both stations in 1991 (Table 3). In 1992, stations 20 and 22 again were similar to each other and to station 18. The pollution index decreased slightly from station 20 to station 22 (Figure 8), while the siltation index increased (Figure 9) due to a slight increase in relative importance of PT group 2 diatoms (Figure 6). These changes may indicate a higher degree of environmental stress on the biota at station 22 than at station 20. Shannon diversity declined slightly at station 20, then rebounded at station 22 to a higher level than was seen at station 18 (Figure 7). This was primarily due to a decrease in the relative importance of *Cymbella affinis* at station 22 (Figure 15). Higher siltation index values at both stations 20 and 22 in 1992, and not relatively low diversity index values as in 1991, resulted in biological integrity/overall impairment ratings that were again good/minor for both stations.

At Clark Fork stations 23 (Alberton), 24 (Superior) and 25 (above Flathead R.) in 1991, Shannon diversity increased with distance downstream, from a low at station 23 comparable to Huson, to a high at station 25 comparable to that above Missoula (Figure 7). This increase in diversity was again related to the decrease in relative importance of the dominant pollution tolerant diatom *Cymbella affinis* (Figure 12), and may indicate a decrease in environmental stress. Pollution index and siltation index values remained very constant between stations, and were very comparable to at least the seven previous stations (Figures 8 and 9). Biological integrity was rated excellent, with no overall impairment of aquatic life at stations 23 and 25. Station 24 missed this highest rating by a very slim margin due to a slight increase in the siltation index, and was rated as having good biological integrity/minor overall impairment (Table 3). In 1992, Shannon diversity index values at Clark Fork stations 23, 24 and 25 were virtually constant and unchanged from the very high value at

Huson (station 22)(Figure 7). Pollution index values were slightly lower at stations 23 and 25, again due to increased importance of PT group 2 diatoms (Figure 6). Siltation index values decreased steadily downstream of station 23. Biological integrity/overall impairment were rated as good/minor at station 23, as they were at the last four upstream stations in 1992, due to the slightly elevated siltation index values (Table 4). Stations 24 and 25 had excellent biological integrity with no overall impairment of aquatic life in 1992.

Station 27, Clark Fork above Thompson Falls Reservoir, is located downstream of the confluence with the Flathead R., which would be expected to have a strong influence on the water quality. Diatom species richness and Shannon diversity dropped off considerably from station 25 in 1991, but remained comparable to the upstream station in 1992 (Figures 4 and 7). The pollution index remained very high at station 27, virtually unchanged from station 25 during both years (Figure 8), while the siltation index was the lowest of any station during both 1991 and 1992 (Figure 9). Biological integrity at station 27 was rated as excellent during both years, with no overall impairment of aquatic life (Tables 3 and 4).

Pollution index values are plotted in Figure 16 for the last four monitoring years, 1989-1992. From them it is possible to discern general water quality trends at Clark Fork and tributary stations. While it is difficult to measure the significance of apparent trends, it should be noted that pollution index values are based on the pollution tolerances of many individual diatom species, and therefore contain considerable environmental data in a condensed form. The following observations are derived from Figure 16:

- Water quality appears to be worsening at station 00, Silver Bow Cr. above Butte's Wastewater Treatment Plant.

- While somewhat variable from year to year, water quality has not improved appreciably at any of Silver Bow stations 01-03, and remains poor.

- Water quality appears to have fluctuated widely at station 04, ACM Pond #2 Discharge, but was consistently better than at Silver Bow Cr. above the Warm Spring Ponds.

- At the Mill-Willow Bypass (station 05) and Warm Springs Cr. (station 06), water quality appears to have steadily improved over four years, although the 1992 data for station 05 probably is invalid due to Superfund activities.

- At upper Clark Fork stations, water quality appears to have improved at station 07 below Warm Springs Cr., worsened over the last two years at station 08 near Dempsey, and remained relatively constant at station 8.5 at Sager Lane and station 09 at Deer Lodge. Water quality at station 10, above the Little Blackfoot R., probably has improved, although the trend is mixed.

- Water quality at middle Clark Fork stations 11-13 has been variable over the last four years, and may be declining slightly, although the trend is not well defined.

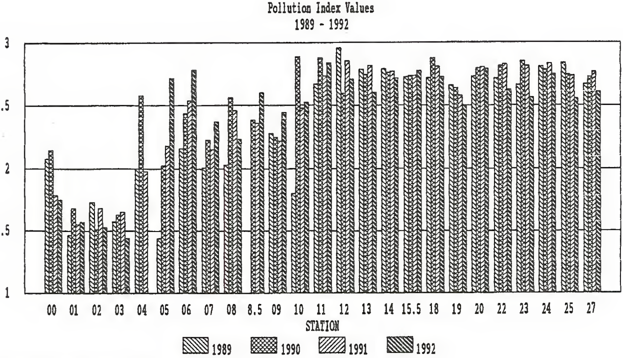
- The Blackfoot R. appears to have consistently high water quality, although a slight downward trend may be discernable.

- At Clark Fork station 15.5, above Missoula, water quality appears to have been consistently high, while minor variability has occurred in the generally high water quality at station 18, at Shuffields.

- Water quality in the Bitterroot R., station 19 appears to be slightly inferior to that in the Clark Fork, and may be declining.

- At Clark Fork station 20, at Harper Bridge, water quality again appears to have been consistently high over four years. While somewhat greater variability is evident at the remaining downstream stations, all appear to have had generally good water quality. Water quality at station 25, above the Flathead R. may have declined slightly over the past four years.

Figure 16. Comparison of Pollution Index values calculated for diatom associations from the Clark Fork and tributaries collected during August of four consecutive years, 1989 through 1992.



Station 8.5 not sampled in 1989.
Station 04 not sampled in 1992.

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APPENDIX A

Non-Diatom Algae Data, 1991

Appendix A

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 12-16, 1991.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station: Sample #:	00 0847F	01 0102L	02 0848G	03 0989G	04 0158J	05 1019F	06 1020F	07 0849I	08 1021F
Bacillariophyta (diatoms)									
All genera collectively	VA(1)	C(4)	VA(1)	C(5)	VA(2)	VA(2)	VA(2)	VA(2)	A(2)
Chlorophyta (green algae)									
Ankistrodesmus	R		R	R		R	A(7)	VC(7)	C(7)
Bulbochaete									
Chaetophora									
Cladophora					C(4)		C(3)		VA(1)
Closterium							R		
Coelastrum					R		C(11)		
Cosmarium				VA(1)	VC(5)	C(6)	R	VC(4)	R
Crucigenia									
Enteromorpha									R
Gloeocystis	VC(2)	C(3)	A(4)	C(6)	R				
Gongrosira							C(10)		
Mougeotia							C(8)		
Oedogonium						VA(1)	VA(1)	A(1)	
Pediastrum	R				A(3)		R	C(5)	
Pseudochaete									
Scenedesmus	VC(4)	C(5)	VA(3)	VA(2)	R	C(8)	C(12)	VC(6)	C(6)
Sorastrum									
Sphaerocystis									
Spirogyra									
Staurastrum									
Stigeoclonium	R	VA(1)	A(2)	R	VA(1)	A(3)			
Tetraspora									
Ulothrix									
Zygnema									
Chrysophyta (yellow-green algae)									
Tribonema		R							
Vaucheria						VC(4)	C(6)		
Cyanophyta (blue-green algae)									
Anabaena									
Aphanocapsa									
Calothrix									
Chamaesiphon									VA(4)
Chroococcus	C(5)		VC(5)	A(3)	R				
Coelosphaerium									
Dichothrix									
Merismopedia						A(5)	R	R	
Microchaete									
Nodularia									
Nostoc							C(9)	VC(3)	A(3)
Oscillatoria	C(6)			VC(4)	C(6)		R	C(8)	R
Phormidium				C(7)	C(7)	VC(7)	A(5)	C(9)	VC(5)
Rivularia									
Synechocystis	VC(3)	VC(2)	C(6)						
Tolypothrix									
Phaeophyta (brown algae)									
Heribaudiella									
Rhodophyta (red algae)									
Asterocystis									
Audouinella							VC(4)		R
Total Non-Diatom Genera	8	5	6	8	10	8	16	9	10

Appendix A (cont.)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 12-16, 1991. (cont.)
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station:	8.5	09	10	11	12	13	14	15.5
Sample #:	1049B	0266P	0850H	0556H	0557H	0558N	0752L	0897I
Bacillariophyta (diatoms)								
All genera collectively	VA(1)	A(2)	A(3)	A(4)	VA(2)	VA(1)	VA(2)	VA(2)
Chlorophyta (green algae)								
Ankistrodesmus	R	C(5)	R		C(14)	C(9)	VC(11)	VC(8)
Bulbochaete								
Chaetophora							C(8)	
Cladophora	VA(2)	VA(1)	VA(1)	VA(1)	A(1)	A(2)		VA(1)
Closterium				R	R	R	R	C(7)
Coelastrum				R	R	R		R
Cosmarium	C(8)	R	R				C(10)	VC(5)
Crucigenia								
Enteromorpha	VC(3)				VC(5)			
Gloeocystis								
Gongrosira		C(4)						
Mougeotia		R			R		C(7)	
Oedogonium								
Pediastrum	C(7)	R	R	R	C(6)	R	R	R
Pseudochaete								
Scenedesmus	C(10)	VC(3)	C(6)	R	C(13)	C(8)	C(12)	C(10)
Sorastrum								
Sphaerocystis								
Spirogyra					VC(3)		VA(1)	
Staurastrum							R	R
Stigeoclonium	VC(5)	R	R	R	C(9)	VC(4)	A(3)	R
Tetraspora	R							
Ulothrix								
Zygnema								
Chrysophyta (yellow-green algae)								
Tribonema								
Vaucheria								
Cyanophyta (blue-green algae)								
Anabaena					C(12)		R	
Aphanocapsa							R	
Calothrix	C(9)				C(10)	C(7)	VC(5)	C(9)
Chamaesiphon	VA(4)	C(7)	VC(5)	VA(3)	A(7)	A(5)		VC(11)
Chroococcus								
Coelosphaerium								
Dichothrix							R	
Merismopedia								
Microchaete			R	VC(6)	C(11)	R		
Nodularia			VA(2)	C(8)	R			
Nostoc	R		A(4)	A(2)	A(4)			A(4)
Oscillatoria	R		R		R			A(3)
Phormidium	A(6)	C(6)	R	VC(7)	VC(8)	VA(3)		C(12)
Rivularia							VC(9)	
Synechocystis								
Tolypothrix				R	R		R	
Phaeophyta (brown algae)								
Heribaudiella							A(4)	
Rhodophyta (red algae)								
Asterocystis					R		R	R
Audouinella	R	R		C(5)	R	C(6)	VC(6)	VC(6)
Total Non-Diatom Genera	14	11	12	13	21	12	19	16

Appendix A (cont.)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 12-16, 1991. (cont.)
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station:	18	19	20	22	23	24	25	27
Sample #:	0676M	0278P	0272Q	0273V	1022F	0901H	0903H	0905L
Bacillariophyta (diatoms)								
All genera collectively	VA(1)	VA(1)	VA(1)	VA(1)	VA(1)	A(3)	VA(2)	VA(1)
Chlorophyta (green algae)								
Ankistrodesmus	C(10)	A(7)	VC(8)	VC(8)	VC(10)	VC(9)	C(13)	VC(13)
Bulbochaete								
Chaetophora							VC(5)	A(2)
Cladophora	VC(2)	C(4)	C(5)	VC(3)	VC(4)	A(1)	A(1)	C(5)
Closterium	C(6)	C(9)			R		VC(6)	C(9)
Coelastrum	R	C(11)	C(9)	C(9)	C(9)	R	VC(10)	C(15)
Cosmarium	VC(5)	VC(6)	C(6)	C(5)	VC(5)	C(7)	A(4)	VC(6)
Crucigenia								
Enteromorpha								
Gloeocystis		R						R
Gongrosira								
Mougeotia								
Oedogonium		R						
Pediastrum	R	C(10)		R	R	R	R	R
Pseudochaete								
Scenedesmus	C(9)	VC(8)	VC(7)	VC(6)	VC(8)	VC(6)	A(7)	VC(11)
Sorastrum								R
Sphaerocystis		R			R			
Spirogyra								VC(3)
Staurastrum		VC(5)	R	R	C(7)			
Stigeoclonium	A(3)	A(3)	VA(2)	VA(2)	VA(2)	C(8)	C(8)	VC(4)
Tetraspora								
Ulothrix		R	R					
Zygnema								
Chrysophyta (yellow-green algae)								
Tribonema								
Vaucheria								
Cyanophyta (blue-green algae)								
Anabaena								
Aphanocapsa					R			
Calothrix	R				R	R	R	C(14)
Chamaesiphon	VC(8)					VA(4)	C(14)	
Chroococcus								
Coelosphaerium								
Dichothrix								R
Merismopedia		R	R				R	
Microchaete								
Nodularia								
Nostoc								
Oscillatoria	C(7)	VA(2)	VC(3)	C(7)	VA(3)	VA(2)	A(3)	R
Phormidium	A(4)	C(12)	A(4)	A(4)	A(6)	VC(5)	VC(11)	A(8)
Rivularia								VC(10)
Synechocystis								
Tolypothrix								
Phaeophyta (brown algae)								
Heribaudiella		R					C(12)	C(12)
Rhodophyta (red algae)								
Asterocystis	R					R	R	
Audouinella	R					R	C(9)	VC(7)
Total Non-Diatom Genera	14	17	11	10	14	13	17	19

APPENDIX B

Non-Diatom Algae Data, 1992

Appendix B

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 10-13, 1992.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station:	00	01	02	03	05	06	07	08
Sample #:	0847G	0102M	0848H	0989H	1019G	1020G	0849J	1021G
Bacillariophyta (diatoms)								
All genera collectively	VA(2)	A(2)	VA(1)	VC(2)	A(5)	A(2)	VA(3)	VA(3)
Chlorophyta (green algae)								
Ankistrodesmus		C(5)	R		A(8)	VC(6)	C(9)	VC(9)
Bulbochaete								
Chaetophora					R			
Cladophora					VC(2)	C(3)	VC(2)	A(2)
Closterium					VC(4)	R	R	VC(5)
Coelastrum						R	R	C(12)
Cosmarium				A(1)	C(7)		C(5)	C(10)
Crucigenia								
Enteromorpha								R
Gloeocystis	C(5)		C(6)	R	R			C(11)
Gongrosira								
Mougeotia					R	VC(4)		
Oedogonium					C(6)	R	VA(1)	VA(1)
Pediastrum					R	R	VC(4)	VC(6)
Pseudochaete						C(5)		
Scenedesmus	R	VC(4)	VC(4)	C(4)	C(10)	C(7)	C(8)	VC(7)
Sorastrum								
Sphaerocystis								
Spirogyra					VA(1)	VA(1)		
Staurastrum								
Stigeoclonium	VC(3)	VC(3)	R		C(9)	R	R	C(8)
Tetraspora							VC(6)	
Ulothrix	A(1)		VC(3)	R				
Zygnema					A(3)			
Chrysophyta (yellow-green algae)								
Tribonema	C(4)	VA(1)	A(2)	R				
Vaucheria								
Cyanophyta (blue-green algae)								
Anabaena			C(5)					
Aphanocapsa								
Calothrix	R							
Chamaesiphon					C(11)		R	C(13)
Chroococcus					R			
Coelosphaerium								
Dichothrix								
Merismopedia					R			
Microchaete								R
Nodularia								
Nostoc					R			R
Oscillatoria				C(3)		R	R	
Phormidium					R		VC(7)	VA(4)
Rivularia								
Synechocystis								
Tolypothrix								
Phaeophyta (brown algae)								
Heribaudiella								
Rhodophyta (red algae)								
Asterocystis								
Audouinella				R		R		
Total Non-Diatom Genera	6	4	7	7	18	13	13	15

Appendix B (cont.)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 10-13, 1992. (cont.)
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station:	8.5	09	10	11	12	13	14	15.5
Sample #:	1049C	0266Q	0850I	0556I	0557I	05580	0752M	0897J
Bacillariophyta (diatoms)								
All genera collectively	VA(1)	A(2)	A(2)	VC(3)	A(3)	VA(2)	A(3)	A(2)
Chlorophyta (green algae)								
Ankistrodesmus	A(8)	VC(8)	VC(7)	C(8)	VC(13)	A(8)	VC(11)	VC(9)
Bulbochaete								
Chaetophora							C(5)	
Cladophora	A(2)	VA(1)	VA(1)	A(1)	VC(2)	A(1)		VA(1)
Closterium		R	R	R	C(5)	C(10)	C(9)	R
Coelastrum			C(9)		R	C(13)	R	R
Cosmarium	R	R	R	R	R	C(11)	C(10)	VC(4)
Crucigenia								
Enteromorpha		VC(3)						
Gloeocystis	R	R			R			
Gongrosira								
Mougeotia								
Oedogonium	R	R	VC(3)	C(4)	R			
Pediastrum	VC(6)	C(7)	C(6)	R	C(6)	VC(6)	R	C(8)
Pseudochaete								
Scenedesmus	VC(7)	VC(6)	VC(5)	C(6)	VC(12)	A(5)	VC(8)	VC(6)
Sorastrum								
Sphaerocystis	R							
Spirogyra							VA(1)	
Staurastrum						R	R	
Stigeoclonium	VC(4)	R		R	C(10)	C(12)	C(6)	R
Tetraspora								
Ulothrix								
Zygnema								
Chrysophyta (yellow-green algae)								
Tribonema	R							
Vaucheria								
Cyanophyta (blue-green algae)								
Anabaena			C(8)					
Aphanocapsa								
Calothrix				R	C(11)	R	C(12)	R
Chamaesiphon	R	VC(10)		VC(5)	A(9)	VA(4)		A(10)
Chroococcus								
Coelosphaerium							R	
Dichothrix					C(7)		R	
Merismopedia							R	
Microchaete								
Nodularia			R	C(9)				
Nostoc	R	VC(5)	VC(4)	A(2)	VA(1)	C(9)		
Oscillatoria	VC(9)				R	A(3)	VA(2)	C(11)
Phormidium	VA(3)	A(4)	R	C(7)	VA(4)	A(7)	VC(7)	VA(3)
Rivularia							VC(4)	C(12)
Synechocystis								
Tolypothrix	VC(5)							
Phaeophyta (brown algae)								
Heribaudiella							R	R
Rhodophyta (red algae)								
Asterocystis	R	R			R	R	R	VC(5)
Audouinella		C(9)		R	C(8)	R	R	C(7)
Total Non-Diatom Genera	16	15	12	14	18	16	20	16

Appendix B (cont.)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, August 10-13, 1992. (cont.)
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Station: Sample #:	18 0676N	19 0278Q	20 0272R	22 0273W	23 1022G	24 0901I	25 0903I	27 0905M
Bacillariophyta (diatoms)								
All genera collectively	VA(1)	VA(2)	VA(1)	VA(1)	VA(2)	A(2)	VA(2)	A(3)
Chlorophyta (green algae)								
Ankistrodesmus	A(7)	A(7)	A(5)	A(7)	A(5)	A(6)	VA(6)	VC(13)
Bulbochaete								R
Chaetophora								A(2)
Cladophora	VC(3)	R	A(2)	A(2)	A(1)	VA(1)	VA(1)	A(1)
Closterium	R		R	R	C(9)	R	R	R
Coelastrum		VC(5)	VC(4)	VC(6)	C(11)	R	R	
Cosmarium	VC(6)	C(9)	C(11)	C(10)	C(10)	C(8)	C(11)	VC(4)
Crucigenia				R				
Enteromorpha								
Gloeocystis		R						R
Gongrosira								
Mougeotia				R				C(9)
Oedogonium		R		R				R
Pediastrum	C(8)	C(6)	C(6)	C(8)	C(8)	C(7)	R	C(6)
Pseudochaete								
Scenedesmus	C(11)	VC(8)	VC(7)	VC(9)	VC(4)	C(9)	VC(10)	VC(8)
Sorastrum								
Sphaerocystis		R						
Spirogyra		C(4)		VC(5)				R
Staurastrum	R	VC(3)	C(10)	R	R			
Stigeoclonium	A(5)		C(8)	A(4)	C(6)	R	C(8)	C(5)
Tetraspora	R							
Ulothrix								
Zygnema				VC(3)				
Chrysophyta (yellow-green algae)								
Tribonema								
Vaucheria								
Cyanophyta (blue-green algae)								
Anabaena								
Aphanocapsa								R
Calothrix		R			R	C(10)		C(11)
Chamaesiphon			R	R	C(12)	C(11)	R	R
Chroococcus								
Coelosphaerium								
Dichothrix					R	R		R
Merismopedia		R	R					R
Microchaete								
Nodularia								
Nostoc						VC(3)		
Oscillatoria	C(10)	VA(1)	C(12)	R			VC(5)	R
Phormidium	VA(2)		A(3)	R	A(3)	VC(4)	VC(9)	C(12)
Rivularia	R				R	VC(5)	A(4)	
Synechocystis								
Tolypothrix							R	
Phaeophyta (brown algae)								
Heribaudiella							R	C(7)
Rhodophyta (red algae)								
Asterocystis	A(4)		C(9)	C(11)	R	R	VC(7)	C(10)
Audouinella	C(9)			R	C(7)	R	A(3)	R
Total Non-Diatom Genera	14	14	14	19	16	16	16	23

APPENDIX C

Diatom Proportional Count Data, 1991

Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1991.
PRA=percent relative abundance; PT=pollution tolerance group number (Lange-Bertalot 1979).
p" indicates species seen during floristic scan but not during count.

1991 STATION:		00	01	02	03	04	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3											0.24		
Achnanthes bioretii	3						p							
Achnanthes clevei	3											p	p	
Achnanthes daonensis	3										p			
Achnanthes exigua	3												p	
Achnanthes flexella	3													
Achnanthes hintzii	3													
Achnanthes hungarica	2								p					p
Achnanthes kriegeri	3													
Achnanthes lanceolata	2	1.45	0.24	p	0.71		26.75	p	0.71	0.73	0.49	0.48	1.21	0.97
Achnanthes lapidosa	3													
Achnanthes marginulata	3			p										
Achnanthes minutissima	3	34.38	27.23	33.33	26.89		7.23	12.59	1.19	2.20	10.10	9.90	4.35	0.97
Achnanthes peragalli	3													
Achnanthes subatomoides	3													
Amphipleura pellucida	2													
Amphora dusenii	2						p							
Amphora inariensis	3							0.24						p
Amphora libyca	3				p		0.24	p				p		p
Amphora pediculus	3			p			p		0.48	0.24	0.25	0.48	1.93	1.45
Amphora veneta	1					18.55	p	0.24	10.48	0.24	p			
Anomoeoneis vitrea	2						p							
Aulacoseira crenulata	3						p				p		p	
Caloneis bacillum	2	p		0.24	0.47		p	0.24	p	0.73		0.24	p	
Caloneis schumanniana	3													
Caloneis silicua	2						p							
Cocconeis neodiminuta	3													
Cocconeis neothumensis	3													
Cocconeis pediculus	3							4.51	0.24	2.44	0.25	p	0.24	5.56
Cocconeis placentula	3	0.24	p	p	p	0.45	8.67	3.80	5.00	28.05	9.36	0.97	2.66	10.63
Cyclostephanos invisitatus	2								p					
Cyclostephanos tholiformis	2	p												
Cyclotella bodanica	2													
Cyclotella comensis	3													
Cyclotella distinguenda	2										p			
Cyclotella meneghiniana	2	3.15	p	0.24	p		p	2.85	11.43	1.95	0.25	p	0.24	p
Cyclotella ocellata	3													
Cyclotella pseudostelligera	2													
Cyclotella stelligera	3													
Cymatopleura solea	2								p	p		p	p	
Cymbella affinis	3							10.69	0.48	p	p	p		0.24
Cymbella angustata	3													
Cymbella caespitosa	2													
Cymbella cistula	3							p	p					
Cymbella delicatula	3													
Cymbella descripta	3											p		
Cymbella elginensis	3													
Cymbella falaisensis	3													
Cymbella gracilis	3													
Cymbella lapponica	3							p						
Cymbella mesiana	3													
Cymbella mexicana	3													
Cymbella microcephala	2							p			p	p		
Cymbella minuta	2	0.48						2.61				p	p	
Cymbella prostrata	3							p						
Cymbella reichardtii	3									p	p	0.97	0.24	
Cymbella silesiaca	3	p	p	p	0.24	p	5.30	7.36	1.67	1.22	0.99	5.80	2.42	1.21

1991 (continued)

	STATION:	00	01	02	03	04	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Cymbella sinuata	3						2.65	1.90	0.48	2.44	1.23	2.17	2.90	0.72
Cymbella subaequalis	3													
Cymbella tumida	3													
Cymbella turgidula	3													
Denticula kuetzingii	3											p		
Denticula tenuis	3													
Denticula valida	3						p							
Diatoma hyemalis	3										p			
Diatoma mesodon	3				p		p	p	p					
Diatoma tenuis	2													p
Diatoma vulgaris	3				p			1.19	p	p	0.25	1.45	0.48	0.24
Epithemia adnata	2					p			p			p		
Epithemia sorex	3				p	p	0.48	p	0.95	1.46	4.19	0.24	13.29	37.92
Epithemia turgida	3													p
Eunotia soleirolli	3												p	
Fragilaria bicapitata	2													
Fragilaria brevistriata	3		p	p	p		p	p					0.24	
Fragilaria capucina	2	0.24	p	p	3.07	p	1.93	12.11	1.90	1.46	1.23	2.90	2.42	0.24
Fragilaria construens	3	p	0.24	p	0.94	p	1.69	1.90	5.24	4.63	3.94	2.42	5.56	5.56
Fragilaria crotonensis	3							1.90						
Fragilaria leptostauron	3		p		p		p	0.48		p	p	p	0.97	0.24
Fragilaria mazamaensis	3													
Fragilaria nanana	3						p					p		
Fragilaria nitzschioides	3													
Fragilaria parasitica	2				p									
Fragilaria pinnata	3			p	0.94		0.96	0.48	0.24	p	p	p	0.24	0.24
Fragilaria tenera	2							0.24						
Fragilaria ulna	2	p			p	p	p	1.43	0.95	0.49	0.99	0.97	1.93	p
Gomphoneis eriense	3													
Gomphoneis minuta	3													
Gomphoneis septa	3													
Gomphonema acuminatum	3			p										
Gomphonema clavatum	2				p	2.26			0.24	0.24	p			
Gomphonema dichotomum	3								p					
Gomphonema gracile	2													
Gomphonema micropus	2			p	p			0.24	0.24	p		0.24	p	0.24
Gomphonema minutum	3								p					p
Gomphonema olivaceum	3						0.24	p	0.24	0.49	5.42	2.90	6.04	0.97
Gomphonema parvulum	1	0.97	1.45	p	0.94	p	1.45	0.24	3.10	0.98	3.94	3.14	p	0.24
Gomphonema procerum	3													
Gomphonema pumilum	3				p			0.24					p	p
Gomphonema rhombicum	3													
Gomphonema sphaerophorum	3													
Gomphonema truncatum	3						p	p	0.24		p	p		
Gyrosigma sciotense	2													
Hannaea arcus	3				p		p	p	p					
Hantzschia amphioxys	2				p									
Melosira varians	2						0.48	8.55	1.67	p	p		p	p
Meridion circulare	3			p	p		p			p	p	p	p	p
Navicula accomoda	1				p									p
Navicula aquaedurae	2			p										
Navicula atomus	1	22.76	18.55	33.10	24.29	4.07	0.24		p			0.24	0.24	0.24
Navicula aurora	3				p									
Navicula bacillum	3							p						
Navicula bryophila	3													
Navicula capitata	2	p		p			p	p					p	
Navicula capitatoradiata	2							3.33	p	p			0.48	0.97
Navicula cincta	2													
Navicula clementioides	3													
Navicula clementis	2						p							

1991 (continued)

STATION:		00	01	02	03	04	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Navicula cryptocephala	3	p				0.23	0.24		1.19		p			
Navicula cryptotenella	2				0.24		p	2.61	9.05	8.54	4.68	1.69	4.11	5.31
Navicula cuspidata	2											p		
Navicula decussis	3	0.24	p		p		1.20		p	p	0.25	p	0.72	0.24
Navicula exilis	3						p							
Navicula gallica	2												p	p
Navicula gastrum	2						p							
Navicula gregaria	2	p							p		p			
Navicula halophila	2								p					
Navicula heimansioides	2													
Navicula ignota	2			p								0.24	p	
Navicula laevissima	3						p							
Navicula lanceolata	2		p				p		0.71	0.24	p	p	p	0.48
Navicula libonensis	2						0.24					p	p	p
Navicula lundii	2													
Navicula meniscula	2						0.24	p	p			p		
Navicula minima	1	10.41	49.40	25.00	32.31	0.23	0.48			0.98	p	2.42	2.66	1.21
Navicula minuscula	1	0.48	p	p	0.24		1.45	0.24		p	p	p	0.24	
Navicula molestiformis	1													
Navicula mutica	2				p									
Navicula oblonga	2													p
Navicula perminuta	2													
Navicula placentula	3										p			
Navicula pseudanglica	2													
Navicula pseudoscutiformis	3													
Navicula pupula	2	0.24		p			p	p	p		p	p	0.48	
Navicula pygmaea	2													
Navicula radiosa	3													
Navicula reichardtiana	2				p		2.89	0.71	0.48	0.73	0.25	0.24	0.24	0.72
Navicula seibigii	2													
Navicula stroemii	2													
Navicula subminuscula	1													
Navicula tenelloides	1													
Navicula tripunctata	3							3.33	0.95	0.49				0.97
Navicula trivialis	2	p					0.48		0.48		p	p		
Navicula tuscula	3			p										
Navicula veneta	1								p	p		1.21	p	
Navicula viridula	2													
Navicula wildii	2													
Neidium affine	3													
Neidium ampliatum	2									p				
Neidium binodeformis	3				p									
Neidium dubium	3													
Nitzschia acicularis	2	0.24		p			2.17	0.24	0.48	0.24	0.99	1.69		p
Nitzschia acidoclinata	3						p							
Nitzschia agnita	1						p							
Nitzschia alpina	3													
Nitzschia amphibia	2					4.52			2.86	0.49	0.25	p		p
Nitzschia archibaldii	2													
Nitzschia capitellata	2	p	p	p	p		p		0.24	0.49	p	0.24	0.48	
Nitzschia communis	1				p		p			p				
Nitzschia dissipata	3	p			p		2.17	4.51	3.10	3.66	6.16	11.35	11.35	6.28
Nitzschia draveillensis	1										p			
Nitzschia flexa	2	p												
Nitzschia flexoides	2				p				0.48	0.49	p			p
Nitzschia fonticola	3					39.82	0.24	1.19	7.14	0.73	0.74	p	p	p
Nitzschia fossilis	2				p									
Nitzschia frustulum	2	p										p		
Nitzschia hantzschiana	3											0.97		
Nitzschia heufleriana	3						p			p		p	p	p

1991 (continued)

STATION:		00	01	02	03	04	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia hungarica	2	p					p		p					
Nitzschia inconspicua	2	p	p	p		0.45	0.96	0.24	0.95	1.46	1.23	7.00	14.98	6.28
Nitzschia intermedia	3								p					
Nitzschia lacuum	3													
Nitzschia liebetruthii	3													
Nitzschia linearis	2	0.48	p	p	p	0.23	6.02	0.48	1.43	1.22	0.25	2.90	0.72	p
Nitzschia palea	1	0.48	0.72	0.24	0.24	20.59	8.43	2.14	6.67	2.68	4.68	10.63	3.62	1.45
Nitzschia paleacea	2	0.24	p	0.24	p	7.92	9.64	3.09	6.67	24.39	35.71	23.19	10.39	4.83
Nitzschia perminuta	3	p		p	0.71			0.71	p	p	p			
Nitzschia pusilla	1	0.24	p				0.24						p	
Nitzschia radicula	2							0.95	1.90	0.49		0.24	p	
Nitzschia recta	3							p				p	0.24	
Nitzschia sigmoidea	3						p				p	p		
Nitzschia sublinearis	2						p							
Nitzschia supralitorea	2						0.96		0.24				p	
Nitzschia tubicola	1	p												
Nitzschia umbonata	1									p				
Nitzschia vermicularis	2				p				p	p				
Opephora ansata	3													
Pinnularia ignobilis	3				p									
Pinnularia microstauron	2											p		
Pinnularia obscura	3													
Rhoicosphenia abbreviata	3	0.24		p	p	0.68	p	p	6.67	2.68	1.72	p	0.48	2.66
Rhopalodia brebissonii	2				p									
Rhopalodia gibba	2				p		0.48				p	p	0.72	p
Simonsenia delognei	2													
Stauroneis kriegerii	3													
Stauroneis smithii	2						0.48	0.24	p		0.25		p	
Stephanodiscus hantzschii	2				p								p	p
Surirella angusta	1	20.58	2.17	6.90	6.60		0.72	p	p	p	p	0.24		p
Surirella brebissonii	2	p			p		0.24		p			p		
Surirella minuta	2	2.42	p	0.71	1.18		1.69		1.19	p		p	0.48	0.72
Thalassiosira pseudonana	2													

STATION:	00	' 01	02	03	04	05	06	07	08	8.5	09	10	11
Frustules Counted:	413	415	420	424	442	415	421	420	410	406	414	414	414
Total Species:	38	23	34	52	20	71	57	67	55	57	68	61	55
Species Counted:	20	8	9	16	13	36	38	41	34	28	33	36	31
Shannon Diversity:	2.58	1.77	1.96	2.43	2.43	3.93	4.34	4.47	3.60	3.45	3.91	4.14	3.45
Siltation Index:	58.84	70.84	66.19	65.80	78.05	40.96	23.75	46.19	47.32	55.17	64.49	51.45	29.71
Pollution Index:	1.79	1.55	1.68	1.65	1.98	2.18	2.54	2.15	2.46	2.36	2.22	2.48	2.73
Total PRA PT Group 1:	55.93	72.29	65.24	64.62	43.44	13.01	2.85	20.24	4.88	8.62	17.87	6.76	3.14
Total PRA PT Group 2:	8.96	0.24	1.43	5.66	15.38	55.66	40.14	44.29	44.39	46.55	42.27	38.89	20.77
Total PRA PT Group 3:	35.11	27.47	33.33	29.72	41.18	31.33	57.01	35.48	50.73	44.83	39.86	54.35	76.09

Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1991.
PRA=percent relative abundance; PT=pollution tolerance group number (Lange-Bertalot 1979).
p" indicates species seen during floristic scan but not during count.

1991 STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3			5.52	0.96	0.24	4.73	0.24	p	0.24	p	p	2.89
Achnanthes bioretii	3						p						
Achnanthes clevei	3						p			0.24	p		p
Achnanthes daonensis	3												
Achnanthes exigua	3						p	p		p			
Achnanthes flexella	3												
Achnanthes hintzii	3			p									
Achnanthes hungarica	2												p
Achnanthes kriegeri	3												
Achnanthes lanceolata	2	0.24	0.49	0.24	p	0.24	0.50	0.49	p	p		0.24	
Achnanthes lapidosa	3												
Achnanthes marginulata	3												
Achnanthes minutissima	3	0.72	0.98	24.94	10.29	3.55	10.70	1.46	3.18	2.15	10.48	2.92	25.78
Achnanthes peragalli	3						p						
Achnanthes subatomoides	3										p		
Amphipleura pellucida	2		p	0.24	p	p	p						
Amphora dusenii	2												
Amphora inariensis	3				p	p	p						p
Amphora libyca	3						p			p			
Amphora pediculus	3	1.68	1.22	1.44	1.20	0.24	0.50	0.49	0.49	1.91	1.43	1.22	0.72
Amphora veneta	1												
Anomoeoneis vitrea	2												0.24
Aulacoseira crenulata	3		p										
Caloneis bacillum	2	p	p	0.24			p						
Caloneis schumanniana	3												
Caloneis silicua	2		0.49					p					
Cocconeis neodiminuta	3												p
Cocconeis neothumensis	3												
Cocconeis pediculus	3	0.24	7.33	0.72	0.48	0.47		p	p	p	p	0.24	
Cocconeis placentula	3	2.40	10.76	2.88	5.98	2.13	3.98	4.63	3.18	9.31	12.38	7.79	1.20
Cyclostephanos invisitatus	2										p	0.73	
Cyclostephanos tholiformis	2												
Cyclotella bodanica	2												p
Cyclotella comensis	3												2.65
Cyclotella distinguenda	2												
Cyclotella meneghiniana	2	p	0.49	p	p	p		p	0.73	0.24	p	7.54	p
Cyclotella ocellata	3												p
Cyclotella pseudostelligera	2										0.24		0.24
Cyclotella stelligera	3												p
Cymatopleura solea	2												
Cymbella affinis	3		1.96	21.82	21.29	64.54	2.24	63.66	62.59	55.37	34.76	28.47	39.04
Cymbella angustata	3												
Cymbella caespitosa	2			0.72	0.24	p			p	p	p		p
Cymbella cistula	3						0.75						
Cymbella delicatula	3												
Cymbella descripta	3												
Cymbella elginensis	3						p						
Cymbella falaisensis	3												
Cymbella gracilis	3												
Cymbella lapponica	3												
Cymbella mesiana	3								p				
Cymbella mexicana	3		p	p									
Cymbella microcephala	2	p		0.96	0.24	p			p	p			5.06
Cymbella minuta	2		p	5.52	1.67	0.24	1.00	0.49	p	0.24	p	0.49	
Cymbella prostrata	3	p		p			p						
Cymbella reichardtii	3			0.24			p						
Cymbella silesiaca	3	0.48	0.24	3.12	1.20	0.24	5.72	0.24	0.24	0.24	0.71	0.24	p

1991 (continued)

	STATION:	12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Cymbella sinuata	3	0.72	2.44	1.68	0.96	2.84	2.74	1.95	1.47	2.39	5.71	3.89	1.45
Cymbella subaequalis	3				p								
Cymbella tumida	3												
Cymbella turgidula	3						2.99		p				
Denticula kuetzingii	3	p											p
Denticula tenuis	3								p				
Denticula valida	3												
Diatoma hyemalis	3												
Diatoma mesodon	3												
Diatoma tenuis	2				p						p	p	1.69
Diatoma vulgaris	3	1.44	p	0.96	2.15	0.24	1.74	2.93	5.38	0.95	1.67	2.68	p
Epithemia adnata	2	0.48	p	0.72									p
Epithemia sorex	3	69.54	41.32	0.96	12.20	2.13		0.24	0.24	0.72	1.19	11.19	p
Epithemia turgida	3	p	p	p						p	0.24	0.24	
Eunotia soleirolli	3												
Fragilaria bicapitata	2											p	
Fragilaria brevistriata	3	p		p									p
Fragilaria capucina	2	0.72	1.47	0.96	3.83	0.95	0.75	0.49	0.49	p	1.43	0.49	6.99
Fragilaria construens	3	3.60	3.91	1.44	2.15	0.71	1.74	p	0.24	0.24	p	4.87	1.20
Fragilaria crotonensis	3												
Fragilaria leptostauron	3	0.96	1.47	0.24	0.48	p	0.25	p		0.24	0.24	p	p
Fragilaria mazamaensis	3		p	p	0.24	0.24	p			p			p
Fragilaria nanana	3			p	p								0.24
Fragilaria nitzschioides	3	p											
Fragilaria parasitica	2				p								
Fragilaria pinnata	3	p	0.73	1.20	1.91	0.71	p	p		p		1.70	p
Fragilaria tenera	2												
Fragilaria ulna	2	0.96	0.24	3.12	3.59	p	1.74	1.95	2.93	6.21	0.48	2.68	6.02
Gomphoneis eriense	3			0.24	p	p	1.00			0.24		0.24	
Gomphoneis minuta	3						0.25	p					
Gomphoneis septa	3												p
Gomphonema acuminatum	3												
Gomphonema clavatum	2				p								
Gomphonema dichotomum	3			p									
Gomphonema gracile	2												
Gomphonema micropus	2			p	p	p							p
Gomphonema minutum	3		0.98	2.40	0.48	p	4.98	0.49	0.24	0.24	1.43	1.22	0.24
Gomphonema olivaceum	3	1.68	1.47	0.96	0.96	0.71		p	0.49	0.24	0.71	0.24	p
Gomphonema parvulum	1	p	p	0.48	0.24	0.24	p			p		p	p
Gomphonema procerum	3			0.48							p		
Gomphonema pumilum	3		p		0.72	0.24	7.21	1.22	1.22	3.10	5.00	3.16	0.96
Gomphonema rhombicum	3			0.48			0.75				p		
Gomphonema sphaerophorum	3												
Gomphonema truncatum	3	p											
Gyrosigma sciotense	2			p									
Hannaea arcus	3			0.48	0.24		p		p				
Hantzschia amphioxys	2												
Melosira varians	2		p		p		0.75						
Meridion circulare	3				p								
Navicula accomoda	1												
Navicula aquaedurae	2												
Navicula atomus	1	p		p			p	p			p		
Navicula aurora	3									p			
Navicula bacillum	3												
Navicula bryophila	3		p	0.24									
Navicula capitata	2						p						
Navicula capitatoradiata	2	p	1.47	3.36	3.11	2.13	7.21	1.95	1.22	1.67	2.14	3.65	0.48
Navicula cincta	2												
Navicula clementioides	3												
Navicula clementis	2												

1991 (continued)

SPECIES	PT	12 PRA	13 PRA	14 PRA	15.5 PRA	18 PRA	19 PRA	20 PRA	22 PRA	23 PRA	24 PRA	25 PRA	27 PRA
Navicula cryptocephala	3						p	p					
Navicula cryptotenella	2	2.16	5.62	2.16	3.59	0.71	2.24	0.98	1.22	2.86	5.71	1.46	0.48
Navicula cuspidata	2												
Navicula decussis	3	0.24	p				0.25	0.24	p	0.48	p	p	
Navicula exilis	3												
Navicula gallica	2												
Navicula gastrum	2												
Navicula gregaria	2						p		p			p	
Navicula halophila	2												
Navicula heimansioides	2												
Navicula ignota	2	p	p	p			0.25	p		p			
Navicula laevissima	3												
Navicula lanceolata	2	p	0.24		0.48	p					p		
Navicula libonensis	2				p								
Navicula lundii	2												
Navicula menisculus	2			p			0.25	p		p		p	
Navicula minima	1		0.49	0.24				p				0.24	
Navicula minuscula	1				p					p			
Navicula molestiformis	1												
Navicula mutica	2		p		p								
Navicula oblonga	2												
Navicula perminuta	2						0.25	p		0.24		p	
Navicula placentula	3			p									
Navicula pseudanglica	2												
Navicula pseudoscutiformis	3			p									
Navicula pupula	2	0.24	p	p	p	p		p	p	0.24	0.24	p	p
Navicula pygmaea	2												
Navicula radiosa	3		p	p									
Navicula reichardtiana	2	0.48	0.73	1.44	1.20	1.18	1.00	0.24	0.49	0.24	0.71	1.46	0.24
Navicula seibigii	2												
Navicula stroemii	2												
Navicula subminuscula	1												
Navicula tenelloides	1		p										
Navicula tripunctata	3		0.49	1.20	0.48	p	0.25	p	1.47	0.48	0.48	1.95	p
Navicula trivialis	2						p	p					
Navicula tuscula	3												
Navicula veneta	1	p	p	p		0.24							
Navicula viridula	2			p									
Navicula wildii	2												
Neidium affine	3												
Neidium ampliatum	2	p											
Neidium binodeformis	3			p									
Neidium dubium	3												
Nitzschia acicularis	2				p		p	0.24		p	0.24	p	p
Nitzschia acidoclinata	3												
Nitzschia agnita	1												
Nitzschia alpina	3			p									
Nitzschia amphibia	2				0.24	p	p	p			p		
Nitzschia archibaldii	2												
Nitzschia capitellata	2	p					p						
Nitzschia communis	1												
Nitzschia dissipata	3	1.92	1.96	4.08	7.89	1.65	4.73	1.22	0.73	1.91	3.10	0.97	0.72
Nitzschia draveillensis	1		p	0.72	0.24	0.24				0.48	0.24	0.49	0.48
Nitzschia flexa	2												
Nitzschia flexoides	2												
Nitzschia fonticola	3	0.48	p	0.48	0.96	0.71	2.24	1.22	0.49	0.48	1.90	0.24	p
Nitzschia fossilis	2												
Nitzschia frustulum	2												
Nitzschia hantzschiana	3	p	p	p	p	p		0.24	0.49	0.72	0.48	0.73	
Nitzschia heufleriana	3	p	p	p									p

1991 (continued)

STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia hungarica	2												
Nitzschia inconspicua	2	1.92	4.16		0.48	1.65	1.24	0.98	0.24	1.19	3.10	0.73	0.24
Nitzschia intermedia	3												
Nitzschia lacuum	3			p						p			p
Nitzschia liebetruthii	3												
Nitzschia linearis	2	0.72	p	p		p		p		p			
Nitzschia palea	1	2.40	0.24	p	0.24	p	2.49	0.49	p	0.72	p	0.24	0.24
Nitzschia paleacea	2	1.92	1.47	0.24	6.22	10.40	19.90	10.73	10.27	3.34	2.36	3.16	0.48
Nitzschia perminuta	3							p					
Nitzschia pusilla	1												
Nitzschia radicula	2	p		0.24		p	p						
Nitzschia recta	3				p	p	0.25						
Nitzschia sigmoidea	3	p											
Nitzschia sublinearis	2				0.24								
Nitzschia supralitorea	2				p	p			p				
Nitzschia tubicola	1												
Nitzschia umbonata	1												
Nitzschia vermicularis	2			p	p								
Opephora ansata	3						0.25				p		p
Pinnularia ignobilis	3												
Pinnularia microstauron	2	p											
Pinnularia obscura	3												
Rhoicosphenia abbreviata	3	1.68	5.13	p	0.96	0.24	0.25	0.49	0.24	0.48	1.19	0.24	
Rhopalodia brebissonii	2												
Rhopalodia gibba	2	p		0.24			p						
Simonsenia delognei	2												
Stauroneis kriegerii	3												
Stauroneis smithii	2			p									
Stephanodiscus hantzschii	2												p
Surirella angusta	1	p			p								
Surirella brebissonii	2		p										
Surirella minuta	2		p		p					p			
Thalassiosira pseudonana	2											1.95	

STATION:	12	13	14	15.5	18	19	20	22	23	24	25	27
Frustules Counted:	417	409	417	418	423	402	410	409	419	420	411	415
Total Species:	51	56	72	62	49	63	48	40	53	47	47	55
Species Counted:	26	29	42	38	29	38	27	25	34	29	36	25
Shannon Diversity:	2.19	3.36	3.96	4.10	2.29	4.29	2.31	2.32	2.82	3.50	3.95	2.85
Siltation Index:	12.47	16.87	14.39	25.36	18.91	42.54	18.54	16.63	15.04	20.71	15.33	3.37
Pollution Index:	2.85	2.82	2.77	2.73	2.81	2.58	2.80	2.82	2.81	2.83	2.73	2.76
Total PRA PT Group 1:	2.40	0.73	1.44	0.72	0.71	2.49	0.49		1.19	0.24	0.97	0.72
Total PRA PT Group 2:	9.83	16.87	20.38	25.12	17.49	37.06	18.54	17.60	16.47	16.67	24.57	22.17
Total PRA PT Group 3:	87.77	82.40	78.18	74.16	81.80	60.45	80.98	82.40	82.34	83.10	74.45	77.11

APPENDIX D

Diatom Proportional Count Data, 1992

Diatom proportional count data, Clark Fork Basin biological monitoring, August 10-13, 1992.
PRA=percent relative abundance; PT=pollution tolerance group number (Lange-Bertalot 1979).
p" indicates species seen during floristic scan but not during count.

1992 STATION:		00	01	02	03	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3						p				0.24		
Achnanthes bioretii	3												
Achnanthes clevei	3												
Achnanthes daonensis	3												
Achnanthes exigua	3												
Achnanthes flexella	3						p						
Achnanthes hintzii	3												
Achnanthes hungarica	2												
Achnanthes kriegeri	3	p											
Achnanthes lanceolata	2	0.47	0.72	0.24	0.24	1.67	p	p	0.49	0.71	0.97	0.71	1.21
Achnanthes lapidosa	3							p					
Achnanthes marginulata	3												
Achnanthes minutissima	3	33.96	19.08	26.19	19.57	60.53	13.46	1.41	0.73	16.63	20.10	2.14	0.72
Achnanthes peragalli	3												
Achnanthes subatomoides	3					p							
Amphipleura pellucida	2					p							
Amphora dusenii	2												
Amphora inariensis	3												
Amphora libyca	3		p	p		p	0.24	p			0.24		
Amphora pediculus	3	p	p				0.24			0.71	0.48	0.24	1.45
Amphora veneta	1							1.88	0.24				
Anomoeoneis vitrea	2					2.63							
Aulacoseira valida	3												
Caloneis bacillum	2	p		p	0.24	p	p			p		p	p
Caloneis schumanniana	3										p		
Caloneis silicua	2												
Cocconeis neodiminuta	3												
Cocconeis neothumensis	3												
Cocconeis pediculus	3		p			p	11.78	5.88	p				5.56
Cocconeis placentula	3	p		p	1.19	p	4.57	7.76	6.59	4.04	8.96	16.43	14.73
Cyclostephanos invisitatus	2			p									
Cyclostephanos tholiformis	2	p											
Cyclotella bodanica	2												
Cyclotella comensis	3												
Cyclotella distinguenda	2						p						
Cyclotella meneghiniana	2	0.70	0.48	p	p	0.24	1.20	16.24	0.98	0.24	0.97	1.67	0.24
Cyclotella ocellata	3												
Cyclotella pseudostelligera	2												
Cyclotella stelligera	3												
Cymatopleura solea	2							p					
Cymbella affinis	3					2.39	0.48	p		0.71	p		p
Cymbella angustata	3					p							
Cymbella caespitosa	2												
Cymbella cistula	3					p				0.71	p		
Cymbella delicatula	3												
Cymbella descripta	3					0.96							
Cymbella elginensis	3												
Cymbella falaisensis	3					0.24							
Cymbella gracilis	3												
Cymbella lapponica	3												
Cymbella mesiana	3												
Cymbella mexicana	3						p						
Cymbella microcephala	2					0.24	p		p	0.24	p		
Cymbella minuta	2	0.23	p		0.24		1.44						
Cymbella prostrata	3						0.24						
Cymbella reichardtii	3									p		0.48	
Cymbella silesiaca	3	p	p	p	p	0.48	8.41	0.47	0.73	2.85	2.91	2.86	0.97

1992 (continued)

	STATION:	00	01	02	03	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Cymbella sinuata	3		p			0.24	0.96	p	0.24	0.24	0.48	0.48	0.72
Cymbella subaequalis	3									p			
Cymbella tumida	3												
Cymbella turgidula	3												
Denticula kuetzingii	3					3.59	p	p		0.24	0.48		
Denticula tenuis	3						0.24						
Denticula valida	3												
Diatoma hyemalis	3												
Diatoma mesodon	3			p			p			p			
Diatoma tenuis	2									p			
Diatoma vulgaris	3		p		p	p	p	p	p	4.28	0.97	0.48	0.24
Epithemia adnata	2				p			p			p		
Epithemia sorex	3		p		p	0.72	0.24	0.47	5.12	18.53	7.99	18.33	38.41
Epithemia turgida	3				p								
Eunotia soleirolli	3												
Fragilaria bicapitata	2												
Fragilaria brevistriata	3				p	p	p		p	p	p		p
Fragilaria capucina	2	0.47	17.39	p	0.48	1.91	2.64	3.29	9.02	4.75	1.21	1.43	0.48
Fragilaria construens	3	1.64	p	p	p	4.31	20.43	12.00	7.32	6.41	5.08	6.67	8.70
Fragilaria crotonensis	3												
Fragilaria leptostauron	3	p	p	p		p	1.92	p	p	0.48	0.24	p	0.97
Fragilaria mazamaensis	3												
Fragilaria nanana	3					0.72							
Fragilaria nitzschioides	3				p	p							
Fragilaria parasitica	2	p	p				p			p			
Fragilaria pinnata	3		p		0.24	0.24	3.61	p		0.24	0.24	0.24	0.48
Fragilaria tenera	2					1.20							
Fragilaria ulna	2	p	p	p	0.24	4.55	0.24	0.94	7.07	6.18	1.45	0.95	1.69
Gomphoneis eriense	3												p
Gomphoneis minuta	3												p
Gomphoneis septa	3												
Gomphonema acuminatum	3						p						
Gomphonema clavatum	2					p	0.96	0.94	1.22	0.95	p	p	p
Gomphonema dichotomum	3												
Gomphonema gracile	2							0.24					
Gomphonema micropus	2			p			p		p				
Gomphonema minutum	3						1.20						p
Gomphonema olivaceum	3			p		0.48	p	p	1.22	3.80	1.94	1.19	2.42
Gomphonema parvulum	1	0.23	3.86	0.24	p	0.72	1.68	3.29	0.73	1.19	0.97	1.43	0.24
Gomphonema procerum	3												
Gomphonema pumilum	3						1.68						
Gomphonema rhombicum	3												
Gomphonema sphaerophorum	3						p						
Gomphonema truncatum	3					0.24	1.20	p	p	p	p		
Gyrosigma sciotense	2												
Hannaea arcus	3												
Hantzschia amphioxys	2												
Melosira varians	2	p			p		0.72	0.47		p			p
Meridion circulare	3		p		p			p			p		
Navicula accomoda	1		p	p									
Navicula aquaedurae	2					0.24			p				
Navicula atomus	1	28.10	14.98	27.62	30.07			p					
Navicula aurora	3			p									
Navicula bacillum	3												
Navicula bryophila	3												
Navicula capitata	2												
Navicula capitatoradiata	2						5.05	1.88	p	p		1.67	0.97
Navicula cincta	2										p		
Navicula clementioides	3												
Navicula clementis	2												

1992 (continued)

STATION:		00	01	02	03	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Navicula cryptocephala	3				p					p			
Navicula cryptotenella	2				p	1.20	0.96	1.65	0.49	2.61	3.39	5.95	4.59
Navicula cuspidata	2									p			
Navicula decussis	3	p	p	p	p	0.48		p	0.49	0.48	0.73	0.24	0.72
Navicula exilis	3												
Navicula gallica	2												
Navicula gastrum	2												
Navicula gregaria	2		p	0.24	p			0.24					
Navicula halophila	2											p	
Navicula heimansioides	2												
Navicula ignota	2			p									p
Navicula laevissima	3												
Navicula lanceolata	2	p	p						p			p	p
Navicula libonensis	2					p	p	p		p			
Navicula lundii	2					p							
Navicula menisculus	2					p	p	p				p	p
Navicula minima	1	16.86	12.56	33.10	39.38	p	p		p		0.48	0.71	0.48
Navicula minuscula	1	1.64	p	0.24	3.10		p	0.24	0.24	0.24	p	p	
Navicula molestiformis	1		p										
Navicula mutica	2			p	p								
Navicula oblonga	2												
Navicula perminuta	2												
Navicula placentula	3								p				
Navicula pseudanglica	2												
Navicula pseudoscutiformis	3												
Navicula pupula	2	0.23	p	p			p		p	0.95	0.73	1.19	p
Navicula pygmaea	2												p
Navicula radiosa	3					p							
Navicula reichardtiana	2		p		p	p	4.09	0.71	0.49	0.24	p	p	1.21
Navicula seibigii	2								p				
Navicula stroemii	2					0.96							
Navicula subminuscula	1												
Navicula tenelloides	1				p								
Navicula tripunctata	3					p	2.16	0.71				p	1.93
Navicula trivialis	2				p				p	p	p	p	p
Navicula tuscula	3												
Navicula veneta	1								p	0.24	0.73	0.48	p
Navicula viridula	2												
Navicula wildii	2					0.48							
Neidium affine	3									p			
Neidium ampliatum	2									p			
Neidium binodeformis	3												
Neidium dubium	3								0.24	p	0.24	p	p
Nitzschia acicularis	2	p	p	p					1.46	1.19	13.56	0.71	p
Nitzschia acidoclinata	3												
Nitzschia agnita	1												
Nitzschia alpina	3								p				
Nitzschia amphibia	2		p			p	p	0.24	p	p	0.24	p	
Nitzschia archibaldii	2				p								
Nitzschia capitellata	2	p	p	p					0.49	p		0.71	p
Nitzschia communis	1		p	p	0.24	p							
Nitzschia dissipata	3	p	p	p	p	0.48	1.44	0.71	0.98	1.90	1.94	5.95	2.66
Nitzschia draveillensis	1												
Nitzschia flexa	2							p				0.24	p
Nitzschia flexoides	2							p	0.24				
Nitzschia fonticola	3	p		p	p		3.13	4.71	1.22	p		1.90	1.21
Nitzschia fossilis	2												
Nitzschia frustulum	2												p
Nitzschia hantzschiana	3					1.67			p	p	p	p	0.48
Nitzschia heufleriana	3							p		p	0.24	p	

1992 (continued)

STATION:		00	01	02	03	05	06	07	08	8.5	09	10	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia hungarica	2												
Nitzschia inconspicua	2	p	p			p		0.47	0.49	p	0.24	2.14	0.97
Nitzschia intermedia	3												
Nitzschia lacuum	3												
Nitzschia liebetruthii	3												
Nitzschia linearis	2	p	p	p	0.24	p	p	0.24	0.49	0.24	0.97	1.19	p
Nitzschia palea	1	0.94	4.11	0.48	0.95	5.50	0.24	0.47	2.44	4.28	9.44	8.57	1.45
Nitzschia paleacea	2			p	p		0.72	23.06	44.39	6.18	6.54	6.43	0.97
Nitzschia perminuta	3				p	0.48	p			p			
Nitzschia pusilla	1	0.23	0.24	0.24		p							
Nitzschia radicula	2							p	1.46	3.33	1.69	0.24	p
Nitzschia recta	3						p	p		p		p	p
Nitzschia sigmoidea	3					p	p	p		p		p	
Nitzschia sublinearis	2												
Nitzschia supralitorea	2					p			0.73		0.24	0.24	p
Nitzschia tubicola	1												
Nitzschia umbonata	1								p		p		
Nitzschia vermicularis	2								p				
Opephora ansata	3												
Pinnularia ignobilis	3												
Pinnularia microstauron	2											p	
Pinnularia obscura	3				p								
Rhoicosphenia abbreviata	3	p			p	p	2.40	9.41	1.95	3.80	2.42	5.71	3.14
Rhopalodia brebissonii	2				p								
Rhopalodia gibba	2				p	0.24	p	p	p	0.24	p	p	
Simonsenia delognei	2												
Stauroneis kriegerii	3		p										
Stauroneis smithii	2						p		p				
Stephanodiscus hantzschii	2				p								
Surirella angusta	1	13.11	26.57	11.19	3.34				p	p	p		p
Surirella brebissonii	2	p	p	p					p		0.24	p	p
Surirella minuta	2	1.17		0.24	0.24	p		p	p			p	
Thalassiosira pseudonana	2												

STATION:	00	01	02	03	05	06	07	08	8.5	09	10	11
Frustules Counted:	427	414	420	419	418	416	425	410	421	413	420	414
Total Species:	35	41	38	46	60	61	54	57	62	54	54	56
Species Counted:	15	10	11	16	31	33	28	31	35	37	34	30
Shannon Diversity:	2.40	2.67	2.06	2.17	2.64	4.04	3.62	3.22	4.09	4.02	4.05	3.41
Siltation Index:	62.30	58.45	73.33	77.57	11.48	17.79	35.29	56.10	21.85	41.40	38.57	17.63
Pollution Index:	1.74	1.57	1.53	1.44	2.72	2.78	2.38	2.23	2.60	2.44	2.52	2.83
Total PRA PT Group 1	61.12	62.32	73.10	77.09	6.22	1.92	5.88	3.66	5.94	11.62	11.19	2.17
Total PRA PT Group 2	3.28	18.60	0.71	1.91	15.55	18.03	50.59	69.51	28.03	32.45	25.48	12.32
Total PRA PT Group 3	35.60	19.08	26.19	21.00	78.23	80.05	43.53	26.83	66.03	55.93	63.33	85.51

Diatom proportional count data, Clark Fork Basin biological monitoring, August 10-13, 1992.
PRA=percent relative abundance; PT=pollution tolerance group number (Lange-Bertalot 1979).
p* indicates species seen during floristic scan but not during count.

1992 STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3			6.16	1.69	0.94	2.41	0.72	0.25	0.24	0.24	0.24	1.17
Achnanthes bioretii	3												
Achnanthes clevei	3	p	0.49		p		0.48	0.24			0.24	0.24	0.47
Achnanthes daonensis	3												
Achnanthes exigua	3												
Achnanthes flexella	3												
Achnanthes hintzii	3			p									
Achnanthes hungarica	2												0.47
Achnanthes kriegeri	3												
Achnanthes lanceolata	2	2.87	3.42	p	0.97	0.24	1.45	0.48	1.23	0.95	0.24	0.95	0.23
Achnanthes lapidosa	3			p									
Achnanthes marginulata	3	p											
Achnanthes minutissima	3	0.24	5.87	34.36	10.90	7.08	7.71	4.58	7.86	5.70	5.20	4.50	26.17
Achnanthes peragalli	3						p						
Achnanthes subatomoides	3									p			
Amphipleura pellucida	2		p	0.47	p		0.24						p
Amphora dusenii	2												
Amphora inariensis	3			0.24	0.24		p		p				
Amphora libyca	3	p										p	
Amphora pediculus	3	1.91	1.96	0.71	1.21	1.18	0.24	p	1.72	2.14	1.18	1.66	1.17
Amphora veneta	1												
Anomoeoneis vitrea	2												0.23
Aulacoseira valida	3						p						
Caloneis bacillum	2	p	p		p								
Caloneis schumanniana	3												
Caloneis silicua	2	p	0.24									p	
Cocconeis neodiminuta	3												
Cocconeis neothumensis	3												0.23
Cocconeis pediculus	3	2.39	3.42	0.47	0.73	0.47	p	2.17	0.74	p	2.36	1.90	0.23
Cocconeis placentula	3	4.78	6.36	2.37	2.91	1.89	4.34	1.45	3.44	5.46	7.09	7.82	3.97
Cyclostephanos invisitatus	2		p		p					p	1.89	22.04	4.44
Cyclostephanos tholiformis	2												
Cyclotella bodanica	2												p
Cyclotella comensis	3												0.47
Cyclotella distinguenda	2												
Cyclotella meneghiniana	2	0.24	1.71		0.24	1.18	1.69	0.48	0.25	3.09	4.73	8.77	0.93
Cyclotella ocellata	3												0.23
Cyclotella pseudostelligera	2										p		p
Cyclotella stelligera	3												
Cymatopleura solea	2	p				p					p	p	
Cymbella affinis	3		3.18	11.37	14.77	40.57	6.99	48.92	18.67	9.98	6.15	8.06	4.21
Cymbella angustata	3												
Cymbella caespitosa	2		p	0.47	0.24	p	0.72	p	0.25	0.24	p	p	1.87
Cymbella cistula	3	p					0.72						
Cymbella delicatula	3												0.23
Cymbella descripta	3												
Cymbella elginensis	3						p						p
Cymbella falaisensis	3												
Cymbella gracilis	3									p			
Cymbella lapponica	3												
Cymbella mesiana	3												
Cymbella mexicana	3		p				p	p				p	
Cymbella microcephala	2			13.03	0.73	1.18		p	p	p			13.55
Cymbella minuta	2		0.98	0.24	0.73	p	3.13	0.96	p	0.71	0.24	0.24	0.23
Cymbella prostrata	3									p			
Cymbella reichardtii	3						p	p					
Cymbella silesiaca	3	p	0.73	1.42	1.21	0.24	9.16	0.48	0.25	0.48	0.95	0.24	0.47

1992 (continued)

STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Cymbella sinuata	3	0.96	1.47	0.71	0.24	0.94	1.20	0.72	1.23	1.19	3.31	3.08	0.93
Cymbella subaequalis	3												
Cymbella tumida	3								p				
Cymbella turgidula	3						0.72			0.24			
Denticula kuetzingii	3												
Denticula tenuis	3				p								
Denticula valida	3												
Diatoma hyemalis	3												
Diatoma mesodon	3										p		
Diatoma tenuis	2							p		p			0.23
Diatoma vulgaris	3	0.24	1.96	p	12.11	2.59	3.61	1.69	3.44	5.23	27.19	0.95	0.23
Epithemia adnata	2	0.24	0.24	p		p							p
Epithemia sorex	3	43.54	15.65	0.47	2.18	0.71	0.96	0.48	4.91	4.75	3.31	4.03	0.93
Epithemia turgida	3		0.24	p							0.24	0.71	p
Eunotia soleirolli	3												
Fragilaria bicapitata	2												
Fragilaria brevistriata	3		p		0.73		p						0.47
Fragilaria capucina	2	1.20	2.44	1.42	3.15	0.71	1.69			0.48	0.47	0.47	7.71
Fragilaria construens	3	8.85	6.60	3.08	8.23	1.89	3.37	2.65	2.70	7.84	6.15	12.09	10.28
Fragilaria crotonensis	3						p						
Fragilaria leptostauron	3	0.96	1.22	0.71	1.45	0.24	0.24	0.24	0.25	0.24	1.89	1.42	1.87
Fragilaria mazamaensis	3			0.24	0.97	0.47	p				p		
Fragilaria nanana	3							p					0.47
Fragilaria nitzschioides	3												
Fragilaria parasitica	2	0.24	p										
Fragilaria pinnata	3	0.72	1.96	2.13	0.73	p	0.72	0.48	1.47	0.71	1.42	0.71	2.34
Fragilaria tenera	2												
Fragilaria ulna	2	0.72	2.20	4.03	5.57	2.36	1.69	4.82	14.00	17.58	4.73	0.71	1.87
Gomphoneis eriense	3	0.24	p	0.47	p	0.24	0.24	p	0.49	p	p		p
Gomphoneis minuta	3						0.24	0.24	0.25				
Gomphoneis septa	3												0.23
Gomphonema acuminatum	3												
Gomphonema clavatum	2	0.24	0.24	0.24									0.47
Gomphonema dichotomum	3												0.47
Gomphonema gracile	2												
Gomphonema micropus	2				p								
Gomphonema minutum	3	1.67	3.42	1.42	1.69	1.18	1.20	1.45	0.98	0.95	1.89	1.66	p
Gomphonema olivaceum	3	0.96	0.49	0.24	3.63	0.47		p	p	p	p	p	p
Gomphonema parvulum	1	p	0.24	p	p		0.24		p				0.23
Gomphonema procerum	3												
Gomphonema pumilum	3			2.61	0.24	0.24	1.20	0.72	0.49	0.24	0.24	0.47	1.64
Gomphonema rhombicum	3			0.47			p					p	0.23
Gomphonema sphaerophorum	3												
Gomphonema truncatum	3				p	p	0.24					p	
Gyrosigma sciotense	2												
Hannaea arcus	3												
Hantzschia amphioxys	2												
Melosira varians	2		0.24		p	0.24	p	0.24	0.74	p			
Meridion circulare	3	p											
Navicula accomoda	1												
Navicula aquaedurae	2												
Navicula atomus	1												
Navicula aurora	3										p		
Navicula bacillum	3			p									
Navicula bryophila	3		p		0.24								p
Navicula capitata	2		p				p						
Navicula capitatoradiata	2	3.83	8.56	3.55	2.18	7.08	18.31	6.75	11.06	8.79	6.38	4.98	1.17
Navicula cincta	2												
Navicula clementioides	3			p									
Navicula clementis	2												

1992 (continued)

STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Navicula cryptocephala	3						p		p				
Navicula cryptotenella	2	6.46	3.67	2.61	2.91	4.95	7.71	3.13	3.93	4.51	0.71	0.95	3.74
Navicula cuspidata	2					p							
Navicula decussis	3	p	p	p	p	p	0.24	p	p	p	0.24	0.47	p
Navicula exilis	3												
Navicula gallica	2												
Navicula gastrum	2			p									p
Navicula gregaria	2												
Navicula halophila	2												
Navicula heimansioides	2						p			p			
Navicula ignota	2	0.24	0.49	p		p	0.24			0.24	0.47	0.24	p
Navicula laevissima	3												
Navicula lanceolata	2	p			p							p	
Navicula libonensis	2		p										
Navicula lundii	2												
Navicula menisculus	2	p	p	0.24	p	p	0.24		0.25			p	
Navicula minima	1	0.24	0.24		p		0.24		0.98	p			
Navicula minuscula	1					p							
Navicula molestiformis	1												
Navicula mutica	2												
Navicula oblonga	2												
Navicula perminuta	2						0.48		0.25		p		
Navicula placentula	3												
Navicula pseudanglica	2			p									
Navicula pseudoscutiformis	3												
Navicula pupula	2	0.24	0.24	0.24	p		0.24	p	0.25	p		p	p
Navicula pygmaea	2												
Navicula radiosa	3		0.24	0.24	0.48	p		p			p	p	
Navicula reichardtiana	2	2.87	1.47	0.95	1.45	1.18	0.72	0.24	1.47	0.71	0.24	0.71	0.47
Navicula seibigii	2												
Navicula stroemii	2												0.47
Navicula subminuscula	1					p							
Navicula tenelloides	1												
Navicula tripunctata	3	p	0.49	0.71	1.69	1.65	p	4.10	3.19	1.90	1.42	1.18	0.23
Navicula trivialis	2			p	p		p						
Navicula tuscula	3												
Navicula veneta	1	0.24	p		p	p							
Navicula viridula	2											p	
Navicula wildii	2												
Neidium affine	3	p											
Neidium ampliatum	2												
Neidium binodeformis	3												
Neidium dubium	3	p	p			p			p				
Nitzschia acicularis	2	p	0.98		p	0.24		p			p	0.71	
Nitzschia acidoclinata	3												
Nitzschia agnita	1												
Nitzschia alpina	3			p	p	p				p			
Nitzschia amphibia	2	p				3.30		0.72	p	0.24			
Nitzschia archibaldii	2												
Nitzschia capitellata	2	p	p				p		0.25				
Nitzschia communis	1	p											
Nitzschia dissipata	3	2.87	1.22	0.95	6.54	3.77	1.20	0.72	2.95	1.19	1.18	0.71	0.47
Nitzschia draveillensis	1			p								p.	
Nitzschia flexa	2		p										
Nitzschia flexoides	2												
Nitzschia fonticola	3	0.48	2.20	p	2.42	7.08	2.17	5.54	5.90	5.94	1.65	0.71	
Nitzschia fossilis	2												
Nitzschia frustulum	2										0.47		
Nitzschia hantzschiana	3		0.98		0.48		0.96	1.20	1.72	1.90	1.42	2.61	0.47
Nitzschia heufleriana	3	p	p	p	p								

1992 (continued)

STATION:		12	13	14	15.5	18	19	20	22	23	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia hungarica	2												
Nitzschia inconspicua	2	0.96	3.42	p	1.21	0.71	2.89	0.72	0.49	2.38	1.42	1.90	0.23
Nitzschia intermedia	3												
Nitzschia lacuum	3			0.24	0.24				p				0.23
Nitzschia liebetruthii	3										0.24		
Nitzschia linearis	2	0.72	0.24		p					p			
Nitzschia palea	1	2.87	0.73	0.24	0.97	0.94	0.48	0.24	p	0.24	0.95	p	p
Nitzschia paleacea	2	1.20	5.87	p	0.73	1.89	5.54	1.93	1.23	2.85	1.18	1.66	
Nitzschia perminuta	3	p				p	p						
Nitzschia pusilla	1												
Nitzschia radicula	2	0.24	0.24	0.24	p	p	0.48			p			0.23
Nitzschia recta	3	p										p	
Nitzschia sigmoidea	3	p	p		p								
Nitzschia sublinearis	2												
Nitzschia supralitorea	2	p	p		p	p							
Nitzschia tubicola	1												
Nitzschia umbonata	1												
Nitzschia vermicularis	2												
Opephora ansata	3						0.48	p		0.48	0.71	0.24	0.70
Pinnularia ignobilis	3												
Pinnularia microstauron	2												
Pinnularia obscura	3												
Rhoicosphenia abbreviata	3	3.35	1.71	p	0.48	p	p	0.48	0.49	0.24	p	p	p
Rhopalodia brebissonii	2												
Rhopalodia gibba	2		p	0.24			0.48						p
Simonsenia delognei	2						p						
Stauroneis kriegerii	3												
Stauroneis smithii	2			p									
Stephanodiscus hantzschii	2												
Surirella angusta	1				p							p	
Surirella brebissonii	2		p										
Surirella minuta	2				0.48	p							
Thalassiosira pseudonana	2												

STATION:	12	13	14	15.5	18	19	20	22	23	24	25	27
Frustules Counted:	418	409	422	413	424	415	415	407	421	423	422	428
Total Species:	60	66	60	66	55	67	47	49	52	50	54	65
Species Counted:	35	44	38	41	34	46	33	37	35	38	36	48
Shannon Diversity:	3.42	4.64	3.61	4.42	3.55	4.48	3.20	4.12	4.20	4.14	4.09	4.04
Siltation Index:	23.44	31.30	10.19	22.03	32.78	42.17	25.30	33.91	30.88	17.97	16.82	7.71
Pollution Index:	2.71	2.61	2.72	2.77	2.73	2.50	2.79	2.62	2.57	2.75	2.56	2.61
Total PRA PT Group 1:	3.35	1.22	0.24	0.97	0.94	0.96	0.24	0.98	0.24	0.95		0.23
Total PRA PT Group 2:	22.49	36.92	27.96	20.58	25.24	47.95	20.48	35.63	42.76	23.17	44.31	38.55
Total PRA PT Group 3:	74.16	61.86	71.80	78.45	73.82	51.08	79.28	63.39	57.01	75.89	55.69	61.21